TUBERCULOSIS

Recast from Lectures Delivered at Rush Medical College, in Affiliation with the University of Chicago

BY

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PREFACE

THE substance of the lectures on Medical Tuberculosis delivered by the author in Rush Medical College during the past three years is embodied in this book. The form of the work has been somewhat changed; some more detail has been introduced, in statistical matter and otherwise, and some few things uttered in the necessity of lecture-room discussion have been omitted.

The treatment of the subject is not, and with the size of the volume could not be, exhaustive; but a correct statement of the science of the disease has been attempted, and at the same time the practical side of the care and management of those sick with its different non-surgical forms, and for the protection of the community from the spread of the disease, has been emphasized.

This latter phase of the subject has heretofore been neglected by many of the profession, to the calamity of both the sick and the well. The old and inadequate way of regarding consumptives and dealing with their diseases was due partly to habit and partly to the gloom with which such invalidism was surrounded. But in this day of better hope for the victims of this amazing disease, and better knowledge of how to prevent it, a new science and a new

gospel need to be taught, to the end that both the profession and the public may be aroused to their duty and opportunities.

This book is submitted in the hope that it may help, if only in a small way, toward this consummation.

The author has great pleasure in expressing his indebtedness to Dr. Henry B. Stehman and Dr. Stanley P. Black for generous and critical assistance in the preparation of the volume.

Los Angeles, California,

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TUBERCULOSIS

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CHAPTER I

THE BACILLUS TUBERCULOSIS

Tuberculosis is the most frequent and destructive disease of man. It attacks many organs and appears in many forms,—forms that have been regarded as distinct diseases and known by a variety of names; and it destroys probably at least one-ninth of all the white races. It is now known to be due to the growth in the tissues of the tubercle bacillus, discovered by Koch in 1882, and no tuberculous lesion exists without the presence of this organism or of the direct influence of its growth and development.

The bacillus tuberculosis is only one of many microbes, pathogenic and non-pathogenic, invading the human body. Most of the micro-organisms are received into the body by inspired air and by food and drink, and the number acquired is enormous. In different atmospheres the number of organisms inhaled by an adult person varies from probably half a dozen to several hundred every

minute of life. Tubercle bacilli are acquired sometimes through direct contact with abrasions of the skin, wounds and orificial mucous membranes, as well as through the respiratory and digestive organs.

Koch's bacillus is a colorless, aerobic, rod-like organism, often slightly curved, probably non-motile

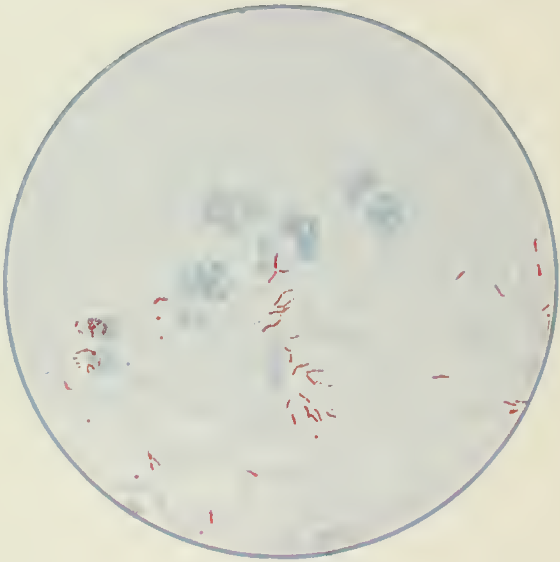

Fig 1.—Bacillus tuberculosis in sputum, stained with carbol-fuchsin and aqueous methylene-blue. $\times 1000$.

and unflagellate, of variable length to the limit of 3.5 or 4 mikrons, or three-quarters of the diameter of an average red blood-corpuscle, and about one-tenth as broad (Fig. 1). It differs in form and size somewhat, and may be branched or nodulated,

all depending on the circumstances under which it has grown and possibly on the bodies through which its generations have passed. The branched or nodulated forms are rarely found save as the result of experimental growth. When stained red, it looks, under the microscope, not unlike a minute cutting of attenuated red hair. Some believe that the different sizes and shapes of the bacilli differ in their infecting powers to the system; the shorter and thicker specimens, which take the stain best, being the product of the severer cases.[1] If this is true, it would argue that these forms are fewer generations removed from their origin in bovine bacilli.

The bacillus is peculiar in containing various oily substances, thought by some to reside in a (rather supposititious) firm surrounding wall, and giving different appearances when treated by various substances, especially alcohol and ether. Cold alcohol extracts 8 per cent. of the total weight of the bacilli, and becomes very red by the change of a form of chromogen in the presence of alcohol and oxygen. From 8 to 20 per cent. or more by weight is extracted by a mixture of alcohol and ether, depending somewhat on the age of the culture. Ruppel has separated from tubercle bacilli a new ptomain which he has named tuberkulosamine. He

[1]Dr. Henry Sewall. *The Medical News,* March 16, 1901.

believes it to exist in the organisms in combination with nucleinic acid.

The tubercle bacillus stains with difficulty, requiring the aid of a mordant like carbolic acid, anilin, or an alkali, but when once stained, it retains its color more tenaciously than most other organisms, and more than the tissues of the body, when treated by decolorizing agents. This power undoubtedly resides in the fatty matters of the bacillus.

Koch has found that the fatty substances which the bacilli contain include two unsaturated fatty acids, one of which is soluble in dilute alcohol, while the other is proof against everything but boiling alcohol and ether. Therefore it must be that the former is removed by the staining fluid which contains alcohol, and that the latter remains after the destaining, and therefore is probably the substance that fixes the stain. It is this staining property that led to the discovery of the bacillus. It was at first supposed that no other bacillus which more or less resembles it had this peculiarity, but several possess it in varying degrees, especially the lepra and smegma bacilli; while those of butter, hay, and grass have similar tinctorial qualities. The smegma bacilli, unlike tubercle bacilli, are decolorized by thorough treatment with absolute alcohol.[1] Several different organisms are more acid-

[1]Dr. George Blumer, Bender Laboratory, Albany, N. Y.

proof than the Koch bacillus. The peculiar staining property of these bacilli is due to the fat they contain or which surrounds them, acquired probably from the substances in which they grow. Remove the fat by alkalis and this property is gone.

The bacillus grows in various artificial media, but, as compared with many other organisms, it is difficult to propagate. The temperature that most favors its growth is about 37.5° C. (99.5° F.), but it does grow at a temperature as low as 60° F. under some circumstances; its development is retarded by any considerable variation from this point. It grows fairly well in blood-serum, acidulated agar agar with glycerin, bouillon with glycerin, and even on cooked potato. It has been grown on filter-paper and on common wall-paper, when moistened by human breath or by aqueous vapor emanating from damp soil.

The bacillus multiplies by division,— whether by manifold division into spores remains to be shown, and is unlikely. Many individual bacilli, presumably the older ones, are seen under the microscope to have the appearance of a string of beads, as though just undergoing division into spores; but it is alleged that the spaces between the red dots are vacuoles, or points in the walls or substance of the bacillus that either have not taken the stain or have relinquished it more quickly to the de-

staining fluid, and that the appearance is no proof of spores.

This bacillus is found in the bodies of various lower animals, where it produces many of the phenomena seen in the human subject. Monkeys, cattle, sheep, goats, swine, horses, chickens, cats, dogs, rats, rabbits, and guinea pigs (even fish fed on tuberculous sputa), and doubtless many other animals, are thus afflicted with tuberculosis, although it rarely occurs spontaneously in domestic animals except cattle. The proportion of slaughtered cattle found to be tuberculous at inspected abattoirs ranges from 4 to 25 per cent. The butter and milk of the market sometimes contain bacilli. The bovine bacillus tuberculosis is shorter than the human and more virulent to other animals. Rabbits inoculated with it die of the disease in from seventeen to twenty-one days, but where human sputum is used they live from six to twelve weeks, and may for a time thrive and get fat, and even bear young. The same effect is found when cattle are inoculated, but it is substantially impossible to produce tuberculosis in cattle by human bacilli.

That the bacillus develops spontaneously outside of the animal body remains to be proved, but the evidence in favor of that possibility is increasing. It was the claim of Koch that it is a pure parasite originating in the animal body, and never spon-

taneously a saprophyte existing outside of it. The recurrence of tuberculosis in certain districts and houses, and the encouragement of the growth of the bacillus by organic vapors, lead to the suspicion that it can and does sometimes grow spontaneously outside the animal body.

No degree of cold yet produced (that of liquid air, more than 300° below Fahrenheit zero) is capable of destroying this bacillus; after exposure for hours to such a temperature it will grow in artificial media. Heat of 82.2° C. (180° F.) promptly kills it, while an exposure of 15 or 20 minutes to a temperature of 60° C. (140° F.) destroys it in milk.[1] Its vitality is reduced or destroyed by prolonged daylight and fresh air acting from five to seven days, while in confined air it retains its virulence for a long time. Sunshine kills it after a period varying from one to twenty-four hours, depending on the intensity of the rays and the directness of their effect upon it; and the intensity depends on the clearness of the atmosphere and its freedom from moisture, either visible or invisible. A virulent sputum exposed to twelve and one-half hours of sunshine daily for four days has failed after forty-three days to induce tuberculosis by inoculation in guinea-pigs. The bacillus is destroyed by strong acids, and even by the degree of acidity

[1]Theobald Smith.

often found in the stomach during digestion, by strong alkalis, and by germicides in general.

The bacillus has a tryptic faculty by which it is capable of transforming various albuminoid substances into peptones and tryptophan. Its life power and its virulence differ according to the animal body in which it is developed. Under certain conditions it has great tenacity of life; it is even capable of being cultivated after it has been for many months incarcerated in scars in the animal body, yet at times it is killed in lung-tissues or old cavities, the expectorated bacilli, if present, being incapable of artificial cultivation.

Certain animals seem to be perfectly immune to this organism. Many are relatively immune — that is, under ordinary conditions of health they do not acquire the disease when inoculated, but do acquire it if greatly reduced in vitality. This is an experience that is nearly identical with that of the human body, which, when in every part perfectly well and vigorous, rarely, if ever, takes the disease. The blood-serum is germicidal to a certain degree, as the leukocytes are, to this organism. Repeated propagation of the bacilli in laboratory media lessens their virulence to animals.

Several *staining fluids* have been used with success for tubercle bacilli, but the most practical is the carbol-fuchsin stain, composed of 1 part fuch-

sin, 5 parts carbolic acid, 10 parts absolute alcohol, and 85 parts water. (The same purpose substantially is accomplished by the following formula: Saturated alcoholic solution of fuchsin, 1 part; five per cent. watery solution of carbolic acid, 9 parts.) This solution may be kept for a number of weeks, but should be renewed the moment it shows any precipitate or fails to stain perfectly.

For decolorizing, a watery solution of nitric or sulphuric acid, 10 to 20 per cent. may be used. Or 3 per cent. hydrochloric acid in a 70 per cent. solution of alcohol. The specimen is immersed in one of these solutions till all red color disappears and till washing with water will not restore it to any considerable degree. Then it should be washed free of acid and mounted, when the bacilli alone will be colored red. A better solution is one that contains a contrast stain, whereby with one process the red color may be removed from all parts of a specimen except the bacilli, and all the other portions stained blue. One such solution is composed of 2 parts or less of methylene-blue (not methyl-blue) to 100 parts of a 25 per cent. watery solution of sulphuric acid. Another solution of perhaps equal value is composed of nitric acid 2 parts, alcohol 3 parts, and water 5 parts, with the addition of methylene-blue to saturation. The use of these solutions leaves the bacilli stained red in

a blue field, which facilitates the search for them under the microscope. When colorless acid solutions are used, a most excellent counter-stain is a 1 per cent. watery solution of malachite-green, which produces instantaneously a beautiful green field, but leaves the bacilli with their red stain undiminished.

The demonstration of tubercle bacilli is not difficult, and any student with an ordinary microscope outfit, including a 1-12 immersion objective and a light-condenser below the stage, can easily become an expert. A few tools and solutions are necessary, and when one begins right and acquires the best methods, he can mount a specimen for the microscope in from five to ten minutes. The things needed are: a spirit-lamp, two needles fixed in handles (the base of a common large sewing-needle forced into the end of a soft piece of wood will do), a Stewart cover-glass forceps, an ordinary dissecting forceps, thin cover-glasses, slides, a solution for staining and another for decolorizing (or a contrast stain), and a bottle of glycerin or Canada balsam.

The sputum is best secured, after rinsing the mouth thoroughly, by having the patient expectorate into a clean dish or a bottle with a wide mouth. Then the sputum should be spread out upon glass over a black surface, and one of the small pearly

lumps or flecks of purulent matter that usually abound in the expectoration should be picked out with the needles for the examination. The bacilli are usually found in these little particles, but they are found nearly as constantly in the larger masses of pure pus. The portion selected should with needles be spread on a cover-glass, or spread out by rubbing it between two of them, which are then pulled apart. It is best not to have the film too thin or too uniform in thickness; if some particles are too thick to be well stained and studied with the microscope, there will be enough other surface for study, and the thicker and darker spots will aid in focusing the microscope. It is, of course, best to examine sputum soon after it is expectorated; otherwise more or less decomposition and granular degeneration will be found in it; but this will not prevent the discovery of the bacilli, which persist in spite of the degeneration.

The film on the cover-glass is to be dried carefully in the heat at a point a few inches above the flame of a spirit-lamp, when it may be passed through the flame rather quickly two or three times, to fix it to the glass. It is then ready for staining, and is to receive from a pipette, while being held level by the cover-glass forceps (which need not let go its bite till all the staining process is done), enough of the carbol-fuchsin solution to cover the

slip as deeply as possible and not have it flow off. This must now be heated slowly to nearly or quite the boiling point.

As soon as this is accomplished the staining is sufficient, and the solution may be washed off with cold water, and the decolorizing solution with the methylene-blue applied immediately and in the same manner. In one minute this solution may be washed off, best by holding the cover-glass edgewise or nearly so in a stream of water; then the specimen is dried by pressure between folds of soft cloth or bibulous tissue-paper or by warmth over the flame, and mounted in water or glycerin for immediate inspection, or in Canada balsam if it is to be preserved. If the specimen is to be kept for any length of time, the balsam must of course be used; and if the acid has been completely washed out, the specimen will keep indefinitely without deterioration; but if any acid remains, it will sooner or later destroy all the color in the bacilli. The red stain should never be allowed to dry on the cover-glass.

If a very careful search is to be made in suspected sputum containing few if any bacilli, the specimen may be centrifugated for five minutes (or sedimented by standing in a test-tube for a day) after its tenacity has been destroyed by caustic soda, and the sediment stained and examined in the usual

way. To liquefy the sputum, water is added in amount depending on the tenacity of the sputum, and then from 1 to 5 per cent. of a saturated aqueous solution of soda, and the mixture boiled until perfect fluidity is produced, but no longer. The sediment secured by the centrifuge will contain elastic fibers from the walls of the air-vesicles if dissolution of lung-tissue is going on, but these will not interfere with the demonstration of bacilli.

In searching for bacilli in urine the centrifuge is used with a fresh specimen, or the urine, anti-septicized with 2 to 5 drops to the ounce of carbolic acid, may be sedimented for twenty-four hours in a deep conical glass and the sediment examined in the usual way, except that a thicker layer of sediment may be spread upon the cover-glass than of the sputum. The best way of all is to centrifugate the lowest dram of the sedimented specimen.

To search for bacilli in milk the same method may be used, only the fat in the sediment is a hindrance, and may be removed by immersing the dried cover-glass preparation in chloroform for five minutes before staining. Suspected butter may be manipulated thoroughly with a little water, the water being then centrifugated. Any bacilli present may be discovered in the sediment. The presence of salt in the mixture does not interfere with the process.

It is difficult to find bacilli in the fluid of *pleural effusion* and in pus from cold abscesses, even when tuberculosis is present; but such fluids injected into the peritoneal cavity of guinea-pigs usually produce tuberculosis.

The discovery of bacilli in animal tissues requires a much more elaborate process. The tissue is first hardened, preferably in absolute alcohol; it is then imbedded in celloidin and cut into sections; the sections are immersed in oil of cloves or in equal parts of alcohol and ether to remove the celloidin, and are then put in alcohol, and finally into water. They are next stained in carbol-fuchsin solution, being allowed to remain in the mixture, kept at room-temperature, for twenty-four hours, although perfect staining will take place in two hours at a temperature of 60° C. (140° F.). They are then decolorized in weak hydrochloric acid (1 or 2 per cent.) in 70 per cent. alcohol, but this process is not carried to the point of complete decolorization. Contrast-staining is done with a 2 per cent. watery solution of methylene-blue. Finally the sections are dehydrated in alcohol, cleared by oil of cloves or xylol, and mounted in balsam.

A large amount of experimental work has been done with tubercle bacilli, in cultures under varying conditions, through artificial tuberculosis in animals, and in efforts to develop in the blood of animals a

substance capable of destroying or repressing the bacilli in the human body.

Certain animals convenient for the laboratory are found very susceptible to tuberculosis, when the bacilli are introduced by means of inoculation of sputum under the skin, by inoculation into the anterior chamber of the eye, or by injection into the peritoneal or pleural cavity or into the blood-vessels. Among these animals the most commonly used are guinea-pigs, rabbits and field mice, named here in the order of their susceptibility. Tuberculosis of the lungs has been produced in laboratory animals by causing them to inhale the dust of dry, powdered sputum; by feeding them on infected sputum they have acquired the disease in the intestinal tract; and after inoculating a part of the body with bacilli a local development of tuberculosis can be produced in a distant part by lowering its vitality in some way, as through traumatic injury to a joint. Cattle prove refractory to these methods to a surprising degree when human sputum is used.

Where local inoculation is performed, the tuberculous process extends from this point by means of the lymph-channels, and attacks the lymphatic glands first reached, which swell and pass through the several stages of the disease.

In efforts to produce a serum for the cure of

tuberculosis, horses and other animals have been subjected to repeated hypodermic injections of pure cultures of the tubercle bacillus, or of the products of artificial bacterial growth, the dosage being so gauged as not to imperil the animal. Gradually a tolerance of the poison is developed; larger and larger doses can be endured without reaction, until finally the animal appears to be immune to the poison. Then the blood-serum (secured by an ordinary phlebotomy) is separated from the other elements of this fluid, is antisepticized for preservation, and is prepared for therapeutic use.

The fluid products of the artificial growth of the tubercle bacillus were first separated from the cultures by the discoverer of the bacillus, and have become known as *tuberculin* or *Koch's lymph.* The substance has come into extensive use for diagnostic purposes for cattle, and to some extent for human subjects, and to a moderate degree as a remedy for tuberculosis. It is obtained usually from a glycerin-bouillon culture of the bacillus, which is concentrated to one-tenth volume by rapid evaporation over a water-bath, and then forced through a porcelain filter to separate the dead bodies of the bacilli. The fluid is then preserved by the addition of some antiseptic, as half of one per cent. of carbolic acid, or an equivalent amount of trikresol. In the evaporation it is, of course, the water, not the glycerin,

that disappears, and so tuberculin is a rather concentrated solution in glycerin. It is proof against rather high temperatures; boiling temperature it stands well, and even higher heat (248° F.). It is tolerably constant, and retains its power and properties for a long time.

One property of tuberculin, when administered hypodermically in even minute doses, is to produce fever in animals and patients afflicted with any form of active tuberculosis. The fever reaction comes on a few hours after a dose of 1 to 5 milligrams is administered, is attended with all the symptoms which usually accompany fever, and passes off with the usual discomforts a few hours afterward. Ten years ago Koch experimented extensively with tuberculin on different forms of tuberculosis in the hope of curing the disease, but with little or no success except upon lupus.

Tuberculin is used enormously in many countries for the diagnosis of tuberculosis in cattle, and laws exist in most of the states of our own country requiring, under certain regulations, the examination of cattle and the destruction of those found to have the disease.

Probably there are several substances combined in tuberculin — some derived from the bacilli, and some from the culture media — and it has fairly been inferred that but one ingredient of the mixture

produces the fever. Repeated efforts have been made to eliminate this ingredient, but with only moderate success. Klebs has, as he believes, precipitated it by chemicals, producing a substance which he has named *anti-phthisin;* also another, which is this substance plus an extract from the bodies of the bacilli, and which he has named *tuberculocidin.* These substances produce less fever in tuberculosis than tuberculin does.

Koch has produced two new tuberculin products, which he calls respectively *upper tuberculin* or T O, and *tuberculin residuum* or T R. The T O contains the soluble products of the bacilli, and is nearly identical with the original tuberculin; the T R contains the insoluble parts of the bacilli. In its manufacture the bodies of the dried bacilli are ground into fine powder in a mortar, and centrifugated with water; and the sediment is again dried, ground, and centrifugated, and this process is repeated until the substance of the bacilli is rendered soluble. The fluid of the first centrifugation is T O; the final product is T R. The latter substance is suspended in a 20 per cent. solution of glycerin, and when injected hypodermically does not cause abscesses. The T R has been used to a considerable extent as a therapeutic agent.

Von Ruck has produced a watery extract of tubercle bacilli for a therapeutic agent.

CHAPTER II

THE TUBERCULOUS PROCESS

What happens in the human body infected with tuberculosis? While there can be no tuberculosis without bacilli, tubercles are sometimes absent in this disease. Such cases occur where there is an unusual and rapid dissemination of the tubercle bacilli throughout the body,— to such a degree that the patient dies from the overpowering effect of the poisoning before the tubercle nodules can be formed.

The bacilli do not travel by their own activity, so far as we know, although there is some evidence that they have motile power; but as they develop they spread, because in their very multiplication they must extend. A bacillus divides in the center; it grows, and with its growth it pushes or is pushed into a new field. Then the bacilli are sometimes moved by the leukocytes of the blood, as they migrate outward and inward from the vessels and among the tissues; and, finding their way into the blood-stream, the bacilli are carried far.

What usually happens is the formation of translucent, grayish, spherical nodules 1-25 to 1-8 of an inch in diameter, known as "tubercles," which it

is a property of the bacillus to produce, or to provoke the tissues to produce. The nodules accumulate in distinct masses, giving an appearance known as *tubercular.* We use the term *tuberculous* as meaning affected with tuberculosis; the word *tubercular* as meaning filled with or covered with little granular nodules, whether of tuberculosis or not. Some of the skin diseases are tubercular in their appearance, but are not tuberculous.

The tubercles of this disease develop rapidly and crowd into masses of various shapes and sizes, depending on the tissue and part invaded. This endless development of the tubercles enables them very soon to fill the center of the affected region so that it is one continuous mass, and the tubercular appearance is lost except at the periphery. The tubercles then develop only around the outside, and so the mass spreads. If the disease occurs in the lungs, some of this substance gets into the bronchi. Perhaps the lesion began in the lining of the bronchi, and the material is carried along to fresh regions by the movement of the air in respiration and by gravity, and so spreads, and new foci of the disease begin.

If we cut through a single tubercle and examine its contents, we find it has few morphologic elements, and these substantially constant. Bacilli, of course, are always present; two kinds of cells —

the epithelioid (or endotheliod) and the lymphoid; and the appearance known as the "giant-cell." In histologic examinations the giant-cell has been usually regarded as diagnostic of tubercle. It is not completely so, since it is sometimes found under other conditions; but the presence of tubercle bacilli is diagnostic. There are no blood vessels in the tubercle; as the mass develops the vessels become plugged up and disappear. They may endure for some time among the general tuberculous aggregation in tissues that have not yet become completely transformed, but in the center of a mass that is wholly composed of tubercles there are no blood-vessels.

The giant-cell is a globular body, made up of a central mass of granular substance and around its periphery a few nuclei. These nuclei are never in the center. The center is a homogeneous substance, and is probably in the beginning stage of degeneration. The nuclei are the left-over elements of the epithelioid cells, both the cells and the nuclei that occupied the site of the center of the giant-cell having lost their outlines in the degenerative change. As we see the giant-cell under the microscope it is in section or flattened out, and the nuclei appear around its circumference, but in the site of its growth they probably encompass the central granular mass completely.

When a mass of tubercles attains anything like the size of the end of the little finger, it becomes degenerate in the center, and there begins the process we know as *caseous degeneration,* which is a peculiar form of necrosis. The tendency of all tuberculous nodules is toward this change in the center, and I believe the inside of a giant-cell illustrates the beginning of the process. The caseous substance has crudely the appearance of soft cheese, hence its name. Poverty of blood in the center of the tuberculous mass and lack of nourishment for the cells contribute to the degeneration.

This is one of the things that the bacilli do — they cause the development of masses of tubercles, and the plugging of the vessels so that the center of the mass loses its nutrition, and thereby becomes degenerate as a necessary consequence. In course of time the caseous matter undergoes a further degeneration and becomes soft and semi-liquid; it has at first a battery consistency, then a more liquid form; and finally chemical changes in its substance produce certain acids. These last unite with the lime-salts that are dissolved in the blood and are present in this liquid, and produce small stony particles, the calcareous degeneration of the caseous matter. Patients occasionally expectorate these little masses of the size of a small fingernail or even larger.

In a cavity of a lung the bacilli often die. They also die in the center of a tuberculous mass; and if a compact pile of tubercles is examined, it will be found that the bacilli thrive most around the outside, where they can find the nourishment they require; they cannot find it in the center of the mass. We have heretofore found that acid substances are inimical to tubercle bacilli. Acids are produced in the degeneration of tuberculosis, and probably kill many bacilli, while more die from want of adequate nutriment. In the growth of pure cultures the organisms develop something that destroys themselves,— a thing that is illustrated by the history of most other germs. As the tuberculous mass spreads, it often produces more or less ordinary inflammation, so we have that added to the tuberculous process.

Not only is there development of tubercles in a mass, but the disease occurs on surfaces — the skin and mucous and serous membranes — where no such aggregations can be formed. In the mass, degeneration goes on in the center; on the surfaces, ulcers are often produced instead, as in lupus and intestinal ulceration. Degenerate masses are extruded, and the products of the disease are cast off as they form. The products of the ulceration represent what in a parenchymatous organ is the caseous center of a degenerate mass. In surface

tuberculosis the disease sometimes remains quite superficial, but sometimes it burrows rather deeply.

Inflammation often occurs around the tuberculous areas. Not only this, but that which usually happens in inflammatory processes — namely, the growth of pus microbes. Hence we have purulent discharge from the ulcers and from the cavities produced by the liquefaction of a tuberculous mass, and the patient absorbs some of the products of this suppuration; as a consequence, more or less general infection ensues. There result chills, fever, and sweating of various degrees, which we recognize as belonging in some way to the disease known as septicemia or pyemia. This subject we will discuss later on. I may say, however, that most of the deaths from tuberculosis are produced by this septic poison. The poisoning and the fever wear the patient out. These cases represent what is called *mixed infection* — infection from pus microbes and tubercle microbes and their products. There is reason to suppose that the high fever of pulmonary tuberculosis is always caused by pus products. Many other kinds of fever are produced in this manner.

Nearly all the tissues of the body are obnoxious to tuberculosis. One of the most resistant of them is the walls of blood-vessels, and yet these become

involved, grow friable, and break easily. The usual blood-pressure within ruptures them, and so we have the hemorrhages of consumption. Many times the tuberculous ulcers and cavities heal. They heal with a thick mass of scar-tissue, within which great numbers of bacilli are imprisoned. The scars are weak for a long time, and it is never safe to regard a lesion as cured until the scar is a year or more old. The process that goes on to make the scar is a conservative one — nature's invention evidently for abbreviating the disease — and we call it fibrosis.

When a tuberculous deposit occurs in the lungs, the fibrous tissue of the trabecular structure of the organ round about usually begins to thicken, and the process goes on in a progressive manner, increasing in lines radiating from the center, so that as we examine the lung from time to time we can demonstrate that the fibrosis has extended far beyond the area of the tuberculosis. Fibrosis is most marked directly around the mass of tuberculous infiltration; but it reaches out into the normal tissue, shading off to the perfectly normal lung-substance some distance away. It helps to limit the process of tuberculosis, and it occurs in all degrees from the slightest quantity of fibrous tissue to the most profound dissemination of it through the lungs, producing that form which we

know as *fibroid phthisis.* The fibrosis probably continues to increase for some time after the tuberculosis is healed — after it has segregated the tuberculous mass from the circulation and lymphatics, and after a tuberculous cavity has been opened into a bronchus and is regularly evacuated. In such cases the fever may cease and the patient improve, but the fibrosis continues to spread. If in a case of pulmonary tuberculosis the fibroid change fails to take place, we know that the patient is in greater peril in consequence, that the disease is more likely to spread, and that nature has failed to throw around the lesion any barrier to prevent its spread.

If we were to make a list of the tissues more commonly invaded by tuberculosis, somewhat in the order of their susceptibility, it might be roughly as follows: Lymphatic glands, bronchi, bronchioles, lung-tissue, pleura, joints, larynx, peritoneum, testicles, intestines, bones, cerebral meninges, urinary bladder, kidneys, skin, adrenals, muscles, nerve-sheaths, and blood-vessel walls.

Numerous complications, apparent and real, occur in this disease. It is a question as to many of the so-called complications whether we should not consider them as evidences of the usual spread of the disease. For instance, at the beginning the disease appears in the surface of the lining of a bronchial tube; it extends to the submucous tissue and

then into the lung-tissue; the bacilli get into the circulation and start to grow in a kidney or an epididymis; the trachea is covered more or less with them; they lodge there and are expectorated to a large degree; they remain for hours along the lining of the windpipe; frequently they are aspired back into a healthy bronchus, where they start a new focus of disease; sometimes by a spasmodic cough they are carried into the post-nasal region; more or less phlegm lodges on the hands and gets into cuts and abrasions, and so starts a skin lesion. Tuberculosis of the larynx may set in, and extend up into the pharynx; the bacilli may be swallowed; if there is sufficient acid[1] in the stomach, it destroys them; if not, they pass down the digestive tube, to produce possible ulcers of the intestines. We ought hardly to say that these examples are complications; they are due rather to the natural spread of the disease in a body whose resisting power to the bacilli is lowered.

The disease begins oftenest in the upper part of the right lung. That sometimes recovers with the formation of fibrous tissue; then the disease appears in or near the apex of the left lung. This we recognize as probably due to the aspiration of the bacilli-laden phlegm into the larger bronchus

[1]There is reason to believe that the usual degree of acidity of the gastric contents is not sufficient to repress tubercle bacilli to any great extent.

of the left side. Again, the kidneys become involved, the epididymis, the joints, the sheaths of tendons, and we are apt to say that these are complications; but they really are only examples of the spread of the disease. The joints swell, often too the sheaths of tendons and the fibrous tissues about them, and the patients say they have rheumatism; but these are the legitimate results of the disease in patients who are unable to resist, who have lost the power to destroy the microbes. There is no doubt that the bacilli permeate every part of the body sooner or later. They find in the blood, of course, substances inimical to them, and if the nutrition and general resisting power of the patient are fairly good, they are destroyed; but they grow and thrive if the nutrition and the resisting power are poor.

The epididymis is very susceptible to this infection, though the testicle proper is rarely involved. The movement of fluid from the epididymis into the vesiculæ seminales, bladder, and urethra often causes an extension of the tuberculosis to these parts; and when the bladder is invaded, the disease sometimes travels up into the kidneys by extension, as well as through the blood in a manner similar to that in which it first reached the epididymis and the joints.

One of the most common forms of the disease

that we have to deal with is pleurisy. Most pleurisies are tuberculous. This cannot be demonstrated in the fluid very readily, but inoculation of guinea-pigs with it generally produces the disease. Serous membranes are in a way more resistant than other tissues of the body, and the pleura frequently recovers permanently and no general infection occurs, perhaps because for anatomic reasons absorption into the general circulation is less here than from most other tissues.

Many of the cases of peritonitis that formerly were known by a variety of other names are nothing but tuberculosis. This form recovers in a certain percentage of cases, sometimes by rest and a fresh increment of resisting power, sometimes by surgical aid.

There is a form of tuberculosis of the skin of recent discovery, known as *anatomic tuberculosis*. It produces a roughness of the skin and thickening that resembles chapping of the hands. It spreads, thickening the skin a little, and is very persistent. Men performing surgical operations, dissecting, and making post-mortem examinations occasionally acquire it. The tissues of disease contain but few bacilli.

The rather unusual affection called bronzed skin or Addison's disease, known for many years to be associated with lesion of the adrenals, we now

know to be due generally to tuberculosis of these organs. The disease is characterized by great prostration, profound weakness (patients usually dying of it), and by bronzing of the skin if the patients live long enough. The skin becomes dark in spots, particularly those portions of the surface exposed to the light, and pigmented parts not so exposed, as the genitalia and the area about the nipples.

Therefore, from a few forms of tuberculosis with which the study of the disease started, we easily discover numerous forms; and doubtless other affections, heretofore known by quite different names, will be found to be only variations of this wonderful disease.

CHAPTER III

FORMS OF TUBERCULOSIS

Tuberculosis attacks numerous tissues of the body. It often does this in the course of its spread from a single focus. For example, in lung tuberculosis there is frequently a middle ear infection. The drum becomes inflamed, breaks down in ulceration, and a perforation results. Sometimes the mastoid cells become involved. These complications may improve and go on to recovery with more or less deafness. The mucous membranes are specially prone to this disease. In a proportion of cases the larynx becomes involved — very rarely in a primary way, nearly always consecutive to the lung disease. Laryngeal tuberculosis does not imply that the patient has carried through the larynx an unusual amount of bacillary phlegm and so has infected it, but rather that the resisting power of the part and of the patient is low.

There are two noticeable forms of laryngeal tuberculosis. In one form there is roughening and ulceration of the vocal cords, producing aphonia, which is not dangerous and from which the patient may recover; in the other form the arytenoid regions and the posterior structures of the larynx become

more particularly affected. In the latter condition there are pain, swelling, and perhaps ulceration, sometimes but not always aphonia, and nearly always painful deglutition.

The disease may spread to the trachea, rarely to the esophagus and stomach, and to the bowels, urethra, prostate gland, and kidneys. Fistula in ano, which occurs in many cases of consumption, may or may not at first be tuberculous, but usually it becomes so sooner or later. It is one of the results of abscess by the side of the rectum, caused by the extension of microbic growth through the mucous membrane from this reservoir. This latter event is made possible by the general reduction in bodily vigor and by the local irritation due to retention of fecal matter and to filthy conditions of the parts.

The serous membranes, the pleura, meninges, and peritoneum especially, are often involved. Tuberculous cerebral meningitis is a form that is substantially always mortal. It occurs in children mainly, rarely in adults, save as a terminal event in consumption. In children it may apparently be independent of tuberculosis elsewhere, but it is probably nearly always secondary. The bacilli in some way enter the blood-vessels and reach the membranes of the brain, and through the capillaries produce meningitis. As to the peritoneum and pleura, the

connective tissue beneath these membranes becomes involved. The dense cartilages, the skin, and even the muscles including the heart may be affected; so also may the lymphatic glands and the various secreting organs, as the kidneys, adrenals, liver, spleen, pancreas, and testicles.

There are two forms of tuberculosis of the skin — lupus and anatomic tubercle. This latter occurs mostly on the hands, is probably due to direct infection, and has the appearance of thickened plaques and warts.

Bone tuberculosis, a surgical variety not to be discussed at any length here, is often attended with necrosis. The spongy structure of the bone is most likely to be affected, as the bodies of the vertebræ, where it produces angular curvature of the spine. Osteomyelitis of the long bones is not infrequently tuberculous, and leads to various surgical incidents and deformities.

The joints are involved frequently, the hip and knee especially. The hip disease known as morbus coxarius and white swelling of the knee are usually tuberculous. The tendon-sheaths become involved, those of the wrists most frequently, and attached to their surfaces minute rice-like bodies appear in great clusters, with swelling and some pain, especially on motion. These bodies, like the structure of fibrosis, are mostly fibrous material.

The disease of the glands of the mesentery known as *tabes mesenterica* is generally, if not always, tuberculous. It is infrequent, occurs mostly in children, and is usually mortal. Swelling of the glands of the neck with abscesses, followed by protracted suppuration and the formation of ugly scars, is a common affection, and is known by the general name of *scrofula*. This, too, is an affection of childhood, and is now proven to be almost invariably tuberculous. It is probably always secondary to infection of the tonsils. It is, to my mind, a curiosity in pathology that lymphatic glands can become tuberculous, suppurate, even break open spontaneously, discharge for a long time, recover, and the patients never afterward have tuberculosis otherwise or elsewhere. The tuberculous character of these cases would be doubtful if the proof on this point were less positive.

"Miliary tuberculosis" usually is taken to mean a general sudden explosion of tuberculosis throughout many parts and tissues of the body, with high fever. But as it is referred to in text-books it is, I am sure, a misleading idea. In the descriptions of fevers and the rules for diagnosis of febrile conditions as set forth in the literature of medicine general miliary tuberculosis is regarded as one of the causes of suddenly occurring high fever, and we are asked to balance the evidence between this and

typhoid fever, malarial fever, and some other infections, in a search for the pathology of an attack. But the affection very rarely produces high fever except as a terminal disorder or complication in a patient profoundly poisoned with tuberculosis or greatly prostrated by some other disease. It may in the lungs be chronic, and attended with little fever, and it is not at all uncommon for numerous organs to be involved within a short time, as a terminal event. With a circumscribed deposit of tuberculosis a patient may resist the disease for a long time; but finally it spreads a little, vitality becomes lower, cachexia creeps on, when suddenly numerous organs and tissues become infected within a few days, and death ensues speedily. And this may occur with little fever, and that little very irregular. The frequency of such terminal events in this disease recalls what an eminent writer has said in a general way — that "it is rare for people to die of the diseases that have afflicted them."

The lungs are the chief seat of tuberculosis as a medical disease, and I am sure that most of us have had an imperfect conception of its behavior in these organs. We may profitably classify the disease under a number of forms as it occurs in the lungs and other organs, for this will help to a clearer understanding of its variations. But nature makes no such sharp lines of classification as our

grouping would suggest. These types merge more or less into each other; but the want of some division of this sort is to some extent responsible for the habit of assuming that all cases of lung tuberculosis must follow about the same course — a habit that has led us into many mistakes and done much harm to the patients. Lung tuberculosis is a most variable disease in its manifestations and course.

First let us consider the *fibrous form,* in which there is a great deal of fibrosis, where the lesion begins on the mucous surface, and the fibrosis starts beneath it. The fibrous tissue of the lung becomes thickened. The same material is deposited there as in scar-tissue, and this extends widely in all directions and far from the seat of the bacillary deposit. There is very little breaking down of the lung into masses of degeneration or into cavities. There is little of the caseous degeneration and relatively little suppuration or mixed infection. The progress of the cases is slow. The diseased lung contracts greatly, and, as there is little suppuration, there is little absorption of pus products, and rarely much fever. The cases, as a rule, are unilateral at the beginning, and often remain so. Sometimes both lungs become involved, the second one usually in a less severe way. If the disease is confined to the left lung, it presents an interesting picture of the uncovered heart with its pulsations seen through

the third and fourth costal interspaces. Even the movements of the auricle can often be plainly seen. The measurement of the chest shows marked contraction and there is reduced motion on the affected side. The cases frequently pass into a condition that we call recovery; but it is somewhat questionable whether the recovery is complete, because there is always imbedded within the fibroid tissue many bacilli that retain their vitality for some time, and if the tissue breaks down, they are liable to multiply and reinfect the patient. This form may exist for a long time with slight physical changes, although there is always some debility and shortwindedness.

The second form differs radically from the first in the fact that there is always a sharply circumscribed deposit of tuberculosis. Most often it is in the apex of a single lung, and the physical signs are marked. The fibrosis, which is usually considerable, is within and around the location of the disease, rarely diffused widely throughout the lung. This form shows the effective and economical means that nature employs to abbreviate the disease. It throws a barrier around the affected area that segregates it from the rest of the lung-tissue. Cavities may occur, suppuration take place, and caseous matter and even calcareous granules may be expelled, and yet the sequestration of the mass may

be so secure that other portions of the lungs and body escape completely. These patients frequently recover with contractures and moderate lessening of breathing capacity.

The third form is the same as the second except that little or no fibrosis occurs. The lung-tissue at some point becomes profoundly involved, cavities result, there is high fever from pus absorption, and no tendency to recover. These cases constitute what is known as quick or galloping consumption. They all die: where there is no tendency to fibrosis there is no chance to recover. Such patients frequently die before the other organs are involved. They die, as a rule, of an overpowering mixed infection, and not from the extension of the disease to other organs.

There is a fourth form in which the disease is slight and is confined to one lung for years, with no extension to other organs and with little effect on the general nutrition. Fibrosis is considerable; there is little or no fever, and the patients pass for healthy people. I believe that in many of these cases the disease is confined to the bronchial mucous membrane almost exclusively. The lining of a bronchus may be a culture field for bacilli for a long time. The mucous formations and other products of the disease are in small amount and rarely expectorated. There is often only moderate

fibrosis with slight contraction of the lung, and such slight change in the tissues that the patients pass for persons in health. Their condition is, however, easily discovered if they happen to run or to make violent exertion, for they are slightly short-winded, showing that the lung-capacity is impaired to some degree. They complain of frequent colds. They cough immediately on getting below their usual physiologic standard; this is their "cold," and on resting and recuperating the "cold" passes off. They may have with these attacks a slight rise of temperature — not enough to impair nutrition much, and so it does not lower their general health. They sometimes even gain in weight and are heavier than before they had the disease. They live for years, and sometimes recover completely.

The fifth form is that in which the disease is confined to the lungs at first and then spreads to other organs — the stomach, intestines, kidneys, testicles, larynx, ears, prostate — in fact becomes a general infection, and death always results. These are the cases in which there is very little natural resisting power, or where the patients are under extremely adverse physiologic and hygienic conditions. They may resist the disease for a little time after it attacks the lungs, when it appears to belong to the second form; but soon there is a rapid spread of the disease to other organs.

The sixth form is the most deceptive of all, and particularly so to the young practitioner. It has a symptomatology of the lungs that leads generally to a mistaken diagnosis. It might be called the fibrous and dissolving form. Diffused moderate fibrosis occurs, disseminated dissolution of the lung-tissues and almost no rales or expectoration. The fibrosis develops in and about the tuberculous masses, and the latter have a diffused, non-solid form. They contract to the degree necessary to choke the blood-vessels that supply the septa between the air-vesicles. As a result, many of the septa break down and are absorbed. Thus two or more vesicles are thrown into one, the respiratory space is reduced, and in consequence the patient breathes more rapidly. There is reduced oxygenation and reduced vitality. These patients do not expectorate, or expectorate little, and of thick, yellow material. There is no dulness on percussion, but great resonance everywhere; generally both lungs are more or less involved, and they are about equally resonant. If both lungs are not involved, then the unaffected one, having to do more duty, develops puerile sounds, and hence resonance on percussion over both sides is loud; auscultation reveals puerile breathing, and so the doctor is confused. The patient coughs, there is loud resonance on percussion, no bronchial breathing any-

where, not a rale to be heard, and the physician is likely to think that the case cannot be one of tuberculosis. He finds that his patient is low in vitality, has a little fever and disorder of digestion and therefore he is tempted to refer the symptoms to some affection of the stomach or general nutrition. But the patient is breathless, and if the doctor listens carefully, he finds with a variety of loud lung sounds that the true vesicular murmur is greatly reduced. The disease progresses slowly but steadily, and if by persistent efforts the patient succeeds in bringing up a little speck of yellow phlegm, it is found to be teeming with tubercle bacilli. This form is steadily progressive, and the patients all die of it, if not cut off by some intercurrent disease.

There is a seventh class, composed of cases that begin with a tuberculous deposit in the right apex, and which recover with some consolidation and contraction, to be followed by a deposit in the upper part of the left lung. In some of these cases the left-sided infection gets well or death ensues without the right side breaking out again. This class is not very numerous, but sufficiently so for identification. I do not remember to have seen the reverse of the experience — that is, where the left apex became infected and recovered, to be followed by infection of the right apex.

There is an eighth class of patients who have

wide and extensive deposits of tubercles scattered rather uniformly over a large part of a lung or both lungs, with almost no pus formation, little or no expectoration, and only a little fever, which may occur irregularly. There may be some dulness on percussion; sometimes the dulness is marked. There are a few fine and faint scattered rales, heard most on inspiration. There is always great dyspnea and a rapid heart-beat. Sometimes the condition is secondary to a rather long existing quiescent tuberculosis in a circumscribed lung area; sometimes it appears to be primary. As there is little pus, mixed infection is rare. The patients all die eventually, but some remain at a standstill for a long time. This form of tuberculosis is often misleading to the practitioner, but is very instructive. It proves, as injections of Koch's lymph do, that the pure infection of tuberculosis may cause fever, the irregular fever of these cases probably being due to the intermittent discharge of the tuberculin into the current of the circulation.

A most proper name for this form of disease would be "miliary tuberculosis."

CHAPTER IV

THE PATHOLOGY OF TUBERCULOSIS

THERE are a few principles that should be kept distinctly in mind as to the pathology of this disease. The tubercle bacillus, like all germs, grows with difficulty except under favoring conditions. It finds a good culture field in many tissues and organs of animal bodies. Normal tissues of the human body, and especially blood, are inimical to the growth of it, and the blood that is shed appears to be most so. As long, therefore, as the blood in the body can be kept up to a strictly normal standard, a great number of bacilli may be thrown into its current and carried to distant organs without starting tuberculous growths in any of them. The blood will kill the bacilli if its normal state is maintained. The vigor of the constitution must be lowered where tuberculosis spreads through the blood-current. It has long been known that patients with pulmonary tuberculosis who have occasional slight hemorrhages are more likely to recover than others.

A patient will often make a sudden slight improvement after a moderate hemorrhage. We were at a loss to understand why this was so until it was

discovered that the blood outside of the vessels has a power more destructive to microbes than that inside. Blood-vessel walls in the course of the disease become invaded and rupture; the blood flows out and surrounds these broken vessels, fills the cavities, flows along the bronchi, and doubtless kills many of the bacilli. It is true that it also washes away some of the products of the disease and helps to get them out of the body, which is useful so far as it goes.

There are different degrees of antagonism to tuberculosis in different human bodies; some have a great deal, and some have very little. Different ages, the sexes perhaps, and different races all have their variations, and there is a marked variation in hereditary susceptibility. Very young persons or children with tuberculosis of the lungs sometimes show relatively great resisting power. A child of twelve years with tuberculosis of the lungs may go on to maturity, resisting the inroads of the disease, and recover. There seems to be something in the physiologic evolution of developing tissue that increases the protecting substance in the blood. Let a person contract the disease at eighteen or twenty years of age, and it will be more likely to terminate fatally; but if the disease comes on at thirty or forty, the likelihood of recovery will be much greater.

It may therefore be said that the normal resisting power must become lowered in a part before the disease can start. It must be lowered in some way; and there are different ways, and probably ways of which we must be long ignorant. The lining of certain bronchi is markedly susceptible. Here the resistance may be diminished by an inspired foreign body that irritates the part and destroys the ciliæ that cover the cell surface, or by some other unknown influence. Then tubercle bacilli are carried to the point by the blood-current, or more likely by the inspired air; here they start a culture and produce the disease. Not one bacillus will do this. A cell or a patch of them lowered in vitality will probably resist one or two bacilli; but presumably there must be many bacilli deposited in such a spot to start a tuberculous lesion, unless the physical depreciation of the part is extreme. Once started, the process goes on for a length of time, extends to other cells, and causes numerous minute tubercle nodules long before any symptom or physical sign is produced. The lymphoid and epithelioid cells gather about this region of disease; coagulation necrosis takes place, capillaries are closed off by inflammation or thrombosis, and we have the giant-cells with their degenerate centers and the other elements of the tubercle.

In reference to the pathology of the giant-cell

in tuberculosis and other lesions (for it is found in others — even in ordinary ulceration, various non-tuberculous tumors and irritated parts), the evidence is accumulating that this cell in some of its elements is conservative, and exercises some power toward the destruction of micro-organisms. It is believed by some surgeons that giant-cells in the midst of foreign bodies — in silk ligatures in a wound in the meshes of which they burrow — exercise a destructive influence on the foreign body, and are hence beneficial. If such a power exists, it must be by virtue of the nuclei in the periphery of the cell. That the inside of the cell is a mass of beginning degeneration is probable; and it is a question, from a pathologic standpoint, whether in tuberculosis the giant-cell is simply a morbid element produced by the irritation of the bacilli or one of nature's instruments to destroy the latter. Of course, reasoning from analogy, we should be inclined to say that all the processes of tuberculosis are conservative — that even the tubercle itself, which develops around the bacilli, represents an effort of nature to segregate the micro-organisms and destroy them. And while the giant-cell may be composed of nothing but a few epithelioid and other cells with their persisting nuclei and a mass of granular material in the center, these cells may have been gathered together for a conservative pur-

pose, and it may be that the nuclei actually multiply in the periphery of the giant-cell for this very reason. In this way we reach ground where it is difficult to say whether the action of this cell is conservative or is altogether morbid. We know that the leukocytes in the blood do take up and in some degree destroy micro-organisms by the process of phagocytosis. And it is perhaps true that sometimes the leukocytes travel out from the blood-vessels into cavities or surfaces of mucous membranes, gather substances into their mass, and carry them back into the circulation.

As to the ingress of tubercle bacilli to the body, we must remember that the portals of nature for their reception are mostly the nose and the mouth. They are inspired through the nose, and lodge on the mucous membrane of its cavities; they are swallowed or find lodgement in the throat, and remain there, and sometimes produce infection of the pharynx and tonsils and the lymphatic glands in the neighborhood. From the tonsils the infection may travel downward through the lymphatics and invade a lung apex. Infection takes place rarely in the nose, oftener in the larynx, occasionally in the trachea, and very frequently in the bronchi and lungs. Being swallowed, the bacilli produce not infrequently tuberculosis in the alimentary canal, particularly if acids are lacking in

the stomach. They enter wounds and abrasions of the skin and produce direct infection.

Doubtless it is true that a lung tuberculosis may be produced by the bacilli being carried in the blood-current, but this I believe is very unusual. They are generally carried to the lung by the inspired air. A series of cases was studied very carefully by Birch-Hirschfeld to determine the place of origin of lung tuberculosis, and he found that nine-tenths of the cases showed that the lesion began on the mucous surface of the medium-sized bronchi. One case only began in the deep tissue of the mucous membrane. This question is a very difficult one to decide, since little help can possibly be derived from an advanced case of tuberculosis or from post-mortem studies of the disease. Tuberculosis begins in the apex of the lung more often than in other portions, and in the right side rather oftener than in the left. Theories in explanation of these facts have been numerous, one of which is that the size and position of the main bronchus on the right side favor a deposit of bacilli in the right apex. This, of course, cannot be true, since the large bronchus of the left side is slightly nearer vertical and is more inviting to the deposit of bacilli than the right bronchus. Perhaps the right apex is more susceptible to injuries because it is nearer the outside air and is exposed to more vicis-

situdes. The air in passing into the left apex goes down at an angle of about forty-five degrees and then rises again. On the right side the process is only a little different.

A study of the behavior of inspired dust in the different portions of the lung throws light on the subject. As a result of some careful researches it is found that inspired dust gets into the lower part of the lung more readily than into the upper part. This is what we should expect. Dust enters the base of the lung first, then the middle, and finally the upper portion; it is eliminated soonest and most from the lower part, and remains longest in the apex, which is what we might not expect. Since the bacilli are a part of the dust, we see why the apex should furnish the greatest number of original foci of the disease. But we do not know why the apices fail to expel the dust as promptly as other parts of the lungs.[1] This is a common experience in scientific studies: the phenomena that explain a condition themselves often need to be explained.

Once the tubercle deposit occurs on a mucous or serous membrane, its products are easily carried to distant regions. From a focus in a lung, infecting phlegm is easily carried backward along the

[1] In the bellows movement of the lung in respiration the apex is compressed least and moves least. This is perhaps the explanation of the susceptibility.

bronchial tubes by inspiration, as it is carried forward by coughing. Cough leaves masses of phlegm lodged at all points between the lesion and the larynx, ready to be aspirated back toward the point of origin or into fresh areas or into a region of normal lung by a sudden violent inspiration. If the mucous membrane is below standard, a new focus of infection may easily be produced. The bacilli readily get into the circulation by entering the lymph-current first; the glands become tuberculous, and fail to a greater or less extent to prevent the entry of the bacilli into the blood-current.

In the pleura and peritoneum it is easy to see how this process would spread when once started. In the peritoneum, for example, a small focus exists; adhesions form around it, so that it is segregated — walled off from the rest of the peritoneal cavity — but the peristaltic movement of the intestines and the low vitality of the adhesions cause them to be broken down easily, and the infecting substance is carried to other portions of the peritoneum. It may extend over nearly the whole of the peritoneal surface, sometimes with positive evidence of a more intense process in certain portions, as shown by greater thickening and more degeneration.

As to the pathology of pleuritis, greater difficulty is encountered than is the case in most other forms of tuberculosis. Some pathologists insist that all

cases of pleuritis are tuberculous. At least many are so; but bacilli are hard to find in the effusion, even after careful centrifugation. In some of the very cases in which the bacilli cannot be found, injection of the fluid into the peritoneal cavity of a guinea-pig or a rabbit will produce tuberculosis.

It is an interesting question why tuberculous pleuritis does not more often infect a lung and destroy life. There is no doubt that many patients recover from this form — recover completely, live many years, and die of other diseases. It is the rule that when patients have had it they are predisposed to its recurrence, and not infrequently they acquire afterward pulmonary tuberculosis; but it is no proof that they are going to die of the pulmonary disease, or even to have it. How, then, does the system protect itself from the spread of serous membrane tuberculosis?

The explanation must be in the anatomy and physiology of the membranes themselves. They are inimical to the spread of infection of this kind, as they seem to be sometimes to the spread of infection from pus. These membranes in health are secreting and absorbing fluid all the time. The arrangement is a beautiful one by which just a trifle more fluid is secreted than is necessary to lubricate the surfaces, the excess being carried off by absorption, and a perfect balance being maintained.

As soon as something happens to poison the surface — as the presence of tubercle bacilli or other organisms, or some other irritating thing — some form or degree of a protecting process which we call inflammation sets in and promptly interferes with the normal functions of secretion and absorption; the fluid becomes deficient in amount, or it is retained, fails of absorption, and effusion results. If there is a great deal of pain and some fever and painful respiration, we know we have that form of disorder that usually goes by the name of inflammation, and that this prevents the absorption of the fluid; and if the fluid accumulation is great, then the cavity may fill rapidly and we have the ordinary liquid effusion. If the fibrin-formation is greater, we have a firm deposit that may become organized and cause a few thin adhesions or thick masses that may cause contraction and compression of the lung. If pus microbes in sufficient numbers find their way into the cavity, we have an empyema. It sometimes happens that we find a chest full of fluid—limpid, straw-colored, perfectly liquid, not opalescent at all — and yet there has not been a particle of perceptible fever or pain. The same pathologic events occur in such cases as do in all the others, only not in the same proportion. Probably in every case the same *kinds* of pathologic changes take place; it is the variation in the several

elements that leads to such multifarious symptoms.

We have seen that fibrosis is a conservative process going on around a tuberculous mass in the lung and extending in all directions. How does it happen that in one case there is very little fibrosis, and in another a great deal? It occurs without any relation to the extent of tuberculosis. Sometimes the slightest area of tuberculosis — a mass not larger than a walnut — will cause a great dissemination of fibrosis and an extreme degree of it. We can only say that it is a protecting movement set up by the irritation of the tuberculosis, which is only one of numerous forms of irritation that can cause it. Just the nature of it, the ultimate way of its happening, nobody knows; and it is one of the needs of our study to be able to explain this phenomenon. Not only does it occur as a conservative process in tuberculosis, but it sometimes becomes destructive by the great degree of it in a lung, disabling the organ almost completely.

It is my belief that fibrosis is incited to some degree by the motion of the lung: the greater the motion and violence from the respiration, the greater the fibrosis; the more quiet the lung, the less of this process — exactly as the scar-tissue of a wound or an ulcer is increased by violence and movement of the part, and rapid healing is helped by fixation of the part.

Not only do we have fibrosis in this disease, but it is a major phenomenon in many other diseases as well. We have cirrhosis of the liver, which consists in a fibrosis of the connective tissue of that organ. We have cirrhosis of the kidneys in arteriofibrosis, and the arterial thickening is a form of cirrhosis, and the heart enlarges in all of these cases. We do not know why this last event happens. Then we have cirrhosis of the different parts of the nerve-centers — of the posterior columns, otherwise tabes dorsalis; cirrhosis in patches, or multilocular sclerosis, which often extends upward into the brain; and we have sclerosis of the brain independently. Many tumors or gliomas of the brain are caused in this way by a thickening of the connective tissue of the organ, and in spots. It has generally been supposed that paralysis agitans does not have an organic basis. Occasionally a pathologist has discovered post-mortem evidence of thickening in some part of the connective tissue of the spinal cord or brain, or of the nerves perhaps; but usually they have found nothing of the sort, and the lesions named have been supposed by some to be accidental.

Now by improved methods of staining and slicing of nerve-tissue it is proven that every case of paralysis agitans has an organic basis of this sort — that is, thickening of connective tissue of the

brain or cord. Sclerosis of the skin — scleroderma is just as mysterious as any of the other forms. Clearing up the pathology of one form of fibrosis is very likely to explain many, if not all, of the other forms.

If the phthisical patient lives long enough, the lung fibrosis continues to progress until the tuberculosis is entirely healed or walled in and has been so for several months. As long as it progresses the short-windedness of the patient increases gradually. If the fibrosis reaches an extreme limit, its contraction destroys many minute blood-vessels, and so leads to atrophy of air-vesicle walls and to increasing dyspnea, producing the form of phthisis with little or no expectoration.

I suppose that a correct theory of fibrosis of the lungs will explain fibrosis about the joints. We do not know just why fibrosis occurs around joints, unless it is because the patients have tuberculosis; but just why it seizes a wrist, a shoulder, an ankle, or a knee-joint, producing no ulceration, but some thickening, pain, and disability, we do not know.

The caseous degeneration and calcareous foci are products of destructive changes from poverty of nutrition in the part. A particular kind of nutritional depreciation seems to be required in order to produce cheesy degeneration. Cut off the blood-supply from a part of the lung suddenly, and it will

break down in degeneration, but not the cheesy form; it will be a slough, and will produce in the breath of the individual the aromatic fetor of gangrene. But these masses that undergo cheesy degeneration have had their nutrition cut off in a more gradual way, and very likely some other influence besides this lessening of nutrition plays a part in the process — as, for example, the peculiar character of infection; but I believe that the rate of reduction in nutrition plays as important a part. The calcification from union of cheesy matter and lime-salts is identical with the incrustations that form around foreign bodies, as ligatures and other objects, sometimes imbedded in the body.

Sometimes a tuberculous mass becomes encapsulated; fibrous tissue surrounds it, and it remains in the part as a foreign body, the patient, perhaps, being supposed to be cured. So long as the mass is surrounded by a thick layer of fibrous tissue, it is harmless to the system; but a little rough handling or a lowering of vitality of the periphery may easily lead to a breaking down of its protecting walls and to some of its substance being absorbed, and a quick miliary infection taking place.

It is possible for a person to die of tuberculosis without a single tubercle having been formed. Such cases are exceedingly rare — in fact, occur chiefly in experimental tuberculosis — and they illustrate

how death may result from the influence of enormous swarms of bacilli, and before the reaction of the tissues that usually produces tubercles can take place.

As tuberculosis spreads through a lung, catarrhal pneumonia may occur here and there within the area of its presence, and the alveoli of the lung become filled with debris, epithelium, red blood-corpuscles, leukocytes, and bacilli. Sometimes the lung breaks down in these regions — probably inside the ring of pneumonia—and numerous little cavities form, or a single large one. The pneumonia hastens the breaking down of the tuberculous mass. This pneumonia frequently clears up and sometimes in a most surprising manner, the lung casting off its products as it does those of an ordinary pure lobar pneumonia.

Miliary tuberculosis is a form that occasionally invades a large mass of an organ, a whole lung or both lungs, tubercles developing throughout the mass or in many parts of the body at once. Sometimes in one or both lungs this form may exist for a long time without either breaking down in cavities or leading to mixed infection and high fever. Such cases simply differ from those just spoken of, in which a great dose of tuberculous poison rapidly saturates the system, in the fact that there is in these cases just enough reacting power in

the tissues to produce tubercles. Fever, usually moderate in degree, is produced by the growth and presence of these bodies in miliary invasion, by inflammation, and probably also by the poisoning arising from the products of the bacilli. We have found that a minute dose of tuberculin nearly always produces fever in a body infected with tuberculosis; but a large dose may produce fever in a person not so infected. We must believe, then, that the poison of miliary invasion is able to produce some fever without mixed infection. In some cases of miliary tuberculosis the patient is overpowered in a few days; but in other cases he improves, and we have what may be called chronic miliary tuberculosis. This may last a long time and produce little fever, cough, or expectoration, but may cause great weakness and extreme shortness of breath.

It is a question much studied how the tubercle bacilli are carried from a particular focus to distant parts of the body; and I think we are justified in believing that there are two main avenues of distribution — namely, the blood-vessels and the lymphatics. But the lymphatics can only in a large way carry the bacilli centripetally, while the blood-vessels eventually carry them centrifugally and everywhere.

As to the ultimate pathology of the cachexia, we are perhaps no wiser than we are regarding that

of fibrosis. Our theories of to-day are likely to be changed to-morrow, but we know in a general way that tuberculous cachexia must be in some way produced by the surcharging of the system with poisons of various sorts caused directly or indirectly by the disease. It is impossible for the body to get rid of them. They reduce the capacity for nutrition and demoralize the blood-making power and probably in a similar ratio deprave and impede the excretory functions.

Probably the cachexia of tuberculosis does not differ essentially from that due to other diseases, although it may differ. The red corpuscles are reduced in number; the whites vary greatly in different forms of cachexia, as they are presumably called on by the physiologic forces in varying degrees for the destruction of pathogenic micro-organisms, and perhaps for the manufacture of antitoxins. Manifestly, no new and unusual demand can be made on the physiologic forces, whether it be toward destruction of the enemies of the body or toward repair of its injuries, without tending to throw them out of balance. And when the demand is too heavy, the balance is not recovered. Cachexia ensues then, and perhaps death.

The evidence is conclusive not only that the leukocytes in the blood may exercise a power inimical to the bacilli, but that there is developed in the

blood-serum also a true antitoxin, a substance that is to some degree destructive of the bacilli. It is even demonstrated that the Widal reaction of agglutination of tubercle bacilli in pure culture is sometimes producible by the blood-serum of tuberculous patients.

CHAPTER V

THE ETIOLOGY OF TUBERCULOSIS

The question of how people get tuberculosis is immensely important, since it leads to the subject of prophylaxis, which is the most important of all. We have already seen that the bacilli are carried into the body largely by the air, and that all people, especially those who live in cities, inspire them repeatedly and in varying numbers. We know also that there must be some power residing in the body that resists them as it does other micro-organisms; otherwise everybody would acquire the disease.

The bacilli grow in a good culture-medium wherever it may be, and they find one often in the human body. Perfectly normal animal tissue resists them in varying degrees; there must be, therefore, a weak spot in the body — one weakened by some local condition or extraneous influence, or weak congenitally — to make is possible for the disease to start. Many tissues are able to resist a few bacilli, while they are powerless against a swarm of them.

Frequently a large number of bacilli are required to start a culture in the body. Some writers on the subject have even gone so far as to place the number at a dozen or two.

Animal bodies differ in their resisting power. The various species differ, and different individuals of the same species show a varying resistance to the disease, depending on manifold circumstances. The several tissues and organs of the body differ in their susceptibility. Human beings are subject to the same laws. The susceptibility is both congenital and acquired. The children of people who have had tuberculosis are more likely than others to take the disease. The very fact of his parents having had the disease presumes a reduced power to resist it on the part of any individual. It presumes, but does not prove.

The resisting power to this disease is not, contrary to the generally accepted notion, identical with ordinary physical vigor. The common belief among lay people is that a physically strong person will resist tuberculosis, while a weaker one will acquire it. This is in general untrue. The athletic people have by their strength no protection against tuberculosis. Of course, this is no warrant for any one to permit his vigor to fall below his normal standard. The best resistance for each person is in his normal vigor and development. Therefore athletic exercise, which is so generally invoked as a preventive, is often misused, and often produces an opposite effect. Muscular vigor is no refuge against tuberculosis. Athletes acquire it rather

more readily than thin, weakly people with spare musculature but normal organic vigor. And I have seen many people die of tuberculosis who, I believe, might have lived had they not attempted to recover by becoming athletes. This is not to say that it is a good thing to be debilitated. It is good to have the system up to its normal vigor; but athletic vigor too often consists in an increase of muscular power without a proper balance of the several physiologic forces necessary to ensure proof against pathogenic microbes.

Tuberculosis rarely goes directly from the mother to the child. There are a few instances on record of animals acquiring it *in utero;* so that it cannot be said that bacilli never travel from the mother to the child. But for all purposes of practical study and management we may assume that the disease is always acquired from without, by bacilli taken in from the atmosphere or with food or drink.

Of the influences that invite tuberculosis to an individual, lowered vitality is one of the most important — lowered vitality produced by various disturbances of function. In our divisions of labor, in our occupations that confine us to certain attitudes and certain lines of work that are unvarying, and in our lives that are monotonous, our physical forces are not kept balanced; we exercise too much in one direction and too little in another, and throw

the functions out of balance, and so lower the vitality of the whole system. Thus we increase our susceptibility to the disease.

There is no question that bad air is one of the forces that induce tuberculosis, and people everywhere breathe bad air a great deal of the time. We breathe indoor air most of the time, we are indoors on an average more than half of all the hours, and we never provide — and usually cannot provide — in our working and sleeping places an atmosphere as good as the outdoor air. This influence invites tuberculosis by lowering the vitality of the system as a whole, and by the injury it inflicts upon certain organs.

Then, starvation brought about in one way or another produces tuberculosis. Experiments with animals have proved this. You can introduce into the tissues a large number of bacilli, and if the animals are kept properly nourished and under conditions of good hygiene, they will escape the disease; whereas they succumb promptly when starved or under bad conditions. Many persons undergo a sort of starvation in numerous ways,— not always by lack of food, often by disturbances of digestion and assimilation. The result is exactly as with animals: they are rendered susceptible to the disease. Sometimes the tissues are partially starved, and poisoned even when a large amount of food is

taken regularly: the assimilation is poor and the depuration bad.

Mental worry and discouragement lower vitality and so invite the disease. A class of people who receive ten per cent. less wages than another class doing identical work will show a larger proportion of tuberculosis, even when they have the same quality and amount of food as those with the higher wages, and when the physical stamina of the two classes is substantially identical.

Over-stimulation plays a part in causation. In our intense lives we can hardly avoid overstimulating, in some direction, at some time. If it is not alcohol, it is coffee or tea, or some article of diet, or it is tobacco — if this is really a stimulant. These non-food articles are, sometimes at least, poisons to the brain, and they may disturb assimilation and balance, and so lower the vitality. Excesses in child-bearing and in the indulgence of passions are strains upon the system and lower its resistance to tuberculosis.

The vitality of the system may be lowered by disease, and so tuberculosis ensue. Here, in addition to the reduced vigor, we have some possible secondary effect of the microbes which caused the preceding disease. Typhoid fever, measles, bronchitis, and whooping cough are not infrequently followed by tuberculosis. Sex seems to have little

influence on the acquisition of the disease. Age has a good deal of influence. Children often recover from tuberculosis of the glands, and sometimes even when the lungs are involved. They are able to resist, probably because they are growing and developing. In the years of adolescence the resisting power to tuberculosis seems to be less. The body has perhaps attained its growth, but the tissues and powers are still unhardened, and the system goes down rapidly under the disease. The best hope of recovery is under twelve or over twenty-five years of age. From twenty-five to fifty-five are probably the most resisting years of life.

The resistance shown by the growing body is illustrated in pregnancy. A woman with tuberculosis of the lungs that is making rapid progress, becoming pregnant, may go through this period and the disease seem to stop; it often does stop its progress. Her resisting power has been aroused by the increased and changed physiologic movement of the body due to the new condition. These patients often go down to death speedily after confinement.

The belief is current among the laity that ordinary simple catarrh of the nasal passages and pharynx is likely to lead to tuberculosis of the lungs by some process of traveling downward. But this theory is wholly groundless. These forms of catarrh not only never produce tuberculosis, but they

do no harm of any sort except to the convenience of the patient. So far from causing this disease, catarrh is likely to protect the tissues from contact of the bacilli. The catarrh in certain cases is probably a consequence of physical debility, which itself always invites tuberculosis; but it never travels downward to produce the disease.

Nationality has some influence on susceptibility to tuberculosis. The Jewish people have very little of it; on the other hand, Americans and Irish have it in large proportion, and the negro in America is very susceptible.

Climate exercises little or no protective influence over the individual against the acquisition of tuberculosis. Such a statement will strike many as surprising; but it is true. In Colorado, New Mexico, Arizona, and Southern California, places where invalids are sent in great numbers to recover from the disease, and where they often do recover, people acquire it initially and from the same causes as in other climates. Those climates are not protective *per se*, although they may be slightly so by the outdoor life they make possible. Of course, the resistance is greatest where the climatic worries are least. Altitude, that has been supposed to exercise such a power over tuberculosis, has none to prevent a person from taking it. Dryness of atmosphere probably has no protecting influence, whatever its

therapeutic power may be. Regions of great sunshine and atmospheric diathermancy show a small proportion of acquired cases; but this is probably due less to any influence on human susceptibility than to the greater destruction of the bacilli in the air by the sun's rays.

We acquire the disease mostly through the air, but also through food and drink, as well as by direct contact. The bacilli are taken into the lungs direct; they lodge in the mouth and throat and are swallowed. Thence they enter the mesenteric glands and get into the blood. They also enter the tonsils and pass into the cervical glands and probably the lungs.

We acquire the disease mostly, perhaps wholly, from human sources; possibly sometimes we get it from animal sources, as from milk, yet the evidence is increasing that bovine tuberculosis must be very rarely transmitted to man. Sour milk is quite as capable of carrying the germs as sweet milk. Rarely do we acquire live bacilli from meat, because meat for food is nearly always cooked. It is found that one per cent. of tuberculous cows have the disease in the udder. The milk of infected cows with non-tuberculous udders contains bacilli in 50 per cent. of cases. So there is no lack of bovine bacilli in the milk served by careless or unscrupulous dairymen.

It is almost impossible to produce tuberculosis in cattle, pigs, sheep, and goats by inoculation, inhalation, and feeding with the products of human tuberculosis; while they are easily infected and die speedily from those of the bovine disease. According to Koch, this argues the improbability of the transmission of the disease to man from the flesh and milk of cattle. If it could occur easily, the number of cases of the primary disease of the intestines among children, who subsist largely on cow's milk, ought to be much greater than it is. As a matter of fact, this form of the disease is extremely rare. Of 933 cases of tuberculosis among children in hospitals in Berlin, no case of tuberculosis of the intestines was found except in conjunction with disease of the lungs and bronchial glands (Baginsky). Biedert found but 16 cases of primary intestinal tuberculosis in 3104 autopsies on tuberculous children, or 51-100 of one per cent. And Koch has seen but 2 cases of primary tuberculosis of the intestines post-mortem.

It is certain that the disease is distributed by the sputum becoming dry and being ground into powder, thus forming a part of the dust of the air and scattering the bacilli widely. We get them not only in the streets, but in the dust of our houses. Even when every effort is made to destroy the sputum of patients, a violent and explosive

cough will frequently expel small particles which may alight on carpets, hangings, furniture, clothes, and beards, and so get into the air. Patients often expectorate into their handkerchiefs; these become dry, and when crushed and handled they likewise distribute the bacilli.

Animal bacilli are more virulent than those from human beings. Old cultures that have been kept for a long time in test-tubes and propagated from time to time lose their virulence. It is said that the original stock of bacilli of Professor Koch, that has been kept alive by repeated cultivation, has become non-virulent. On the other hand, if you take a slightly virulent culture and inoculate an animal with it, from this animal another one, and so on, the virulence will increase until the highest point of intensity is reached.

CHAPTER VI

THE SYMPTOMS OF TUBERCULOSIS

The symptoms of tuberculosis do not appear at the beginning of the disease. That is one of the misfortunes of the study and treatment of it. The bacilli grow, spread, and burrow for a time before symptoms or signs appear. The disease begins the moment a few bacilli find a good culture-medium in the body and commence to multiply. They spread, perhaps with the aid of leukocytes that move in most unexpected ways; they burrow into the tissues by their multiplication, and around them the minute tubercles develop. This goes on progressively until one of two or three things occurs: either the appearances are changed and so signs appear, as in local or surface tuberculosis, of which lupus and anatomic tubercle are examples; or there is an organic change and functions become disturbed; or there is lowered vitality from systemic poisoning — or all three together. The patient does not realize it until the appearances change or the functions are altered — the functions of the part or of some other part dependent upon it — or until some new function appears, such as cough, or some calamity like a hemorrhage.

Therefore, in lung tuberculosis we are obliged to wait for evidence until the function of the part is disturbed, as in some impairment of the breathing, or until some effect is produced on the system that lowers its vigor or impairs other functions. And often the first symptom that appears belongs to the third category, that of infection, and consists of reduced vigor, or fever, or both. In a great number of cases the first symptom the patient can tell about is lowered vitality. In some of the lung cases cough or hemorrhage, or both, occur nearly as early. Lowered vitality is expressed by loss of weight, strength, and appetite. At the same time the digestion becomes poor, and the patient may complain of gastric discomfort and diarrhea or constipation.

The body is infected with the poison of the disease, and perhaps with pus products, or wholly by the latter. By the time the pus infection is at all marked, cough occurs and is often vexatious, and daily fever as well, perhaps with chills at the beginning and perspiration at the end. We not only have these changes of function, but we have cough, which can hardly be said to be a change of function. Rather it is one of nature's reserve functions, whose purpose is to relieve the respiratory passages of offensive materials; and it often tries blindly to brush away irritations, which it is powerless to affect.

Discomfort in a lung is a most unusual thing. The patient is uncomfortable because he has a cough, or possibly some pain in the chest-wall. Perhaps he expectorates phlegm, sometimes even a little blood, and that alarms him; but pain, if he has it — and he often has — is not in the lung. It is always in either the walls of the chest or the pleura, or both. He will declare that his lung is sore; but we know that he is mistaken, and that the pain is outside that organ.

The elevation of temperature will be recognized as an evidence of infection, and usually mixed infection. It has wide variations in degree, and if the pus infection is considerable, the fever is liable to rise rapidly and to be announced by a chill, which occurs early in the day. At first it is not a pronounced chill, but a slight chilly sensation that is followed or attended by fever. The temperature is highest in the afternoon and evening, and as it falls the patient may perspire a variable amount. When this condition has been reached the vitality is often much reduced, the power of the body drops, the patient is losing weight, his digestion is impaired, and he begins to acquire that condition known as cachexia. If the temperature rises swiftly at any time, it is proof of pus infection to a considerable degree. If there is a rapid rise of temperature, there is likely to be relatively more profound chills. Then, too,

the temperature is most likely to drop quickly and with profuse perspiration. This is the colliquative sweat of phthisis.

Now these symptoms, which are the general ones of the disease, come in a thousand different ways and in as many different proportions, so that no two patients present the same clinical picture. One patient coughs more than another; one has more fibrous tissue that protects the diseased parts; one gets sick faster than another. As a consequence of personal idiosyncrasy, the irritation in the bronchial tubes or in the trachea is most variable. Hence some victims cough violently or excessively, and others very little. Some patients with tuberculosis have great quantities of pus in the breath channels and the most remarkable rales of all kinds, and yet hardly cough at all. Others cough on the slightest provocation; and they cough violently to raise particles of phlegm no larger than the head of a pin; they even cough from irritation when there is no phlegm to raise. In general these patients resist cough by taking shallow breaths. It is a significant symptom of the disease if the patient coughs on taking a deep inspiration; for then one may know that there is some phlegm in the bronchial tubes, probably the smaller ones, and that the inspiration has drawn some of it peripherally into still more minute tubes whose mucous sur-

face is more normal, and so produced the cough.

Most of the phlegm that these patients raise is mucus even when it looks very purulent. The amount of pus is, as a rule, relatively small. Caseous matter is seldom brought up, and still less often small particles of calcareous matter. The proportion of pus and mucus varies widely at different times and under different circumstances. Blood is occasionally present in the expectoration, and in varying amount, from a mere streak of color to almost pure blood in great quantities. It should not disturb the mind of any patient if the amount is small, for slight bleedings are useful.

The patient nearly always coughs more or less if the tuberculosis begins proximally to the outer surface of the lung — that is, if the bronchi are irritated and if there are unoccluded air-vesicles and bronchioles situated distally to the lesion. If one lung is solely or chiefly affected, and the lesion has not reached the surface of it, the patient always coughs more when he lies on the affected side. This is for the same reason that a deep inspiration causes cough — namely, that the phlegm flows from larger and diseased tubes into smaller and healthy ones. This always sets up coughing. In lying on the affected side, gravity favors this phenomenon.

Let a patient have tuberculosis in the most common point — near the center of the apex of a lung,

with some unaffected bronchi peripherally to it. Fluid will appear in the bronchi of the part, and if the patient lies on the diseased side, the fluid will by its weight tend to flow downward into the smaller tubes; it will pass into tubes that are healthy, set up an irritation, and produce rales and cough. Let the patient now turn on the other side, and the cough will cease, because the affected region is uppermost and the phlegm, in flowing downward, traverses enlarging tubes and finds less and less obstruction. The mucus will stick to the lining of the larger bronchi and trachea, will lose by evaporation some of its moisture, and so, being more concentrated, may remain for many hours. In this way a patient will often retain his phlegm for a whole night; but when he gets up and takes food and drink, more fluid soon appears on the lining of the tubes — oozes from the mucous membrane; this loosens the retained expectoration, which is set in motion by the air-currents and so causes rales or rhonchi; it flows down into smaller tubes; then the patient begins to cough and expectorate. He may expel all the products of a night in a few minutes. A patient will frequently cough almost incessantly during the night if he is obliged to lie on the affected side, while if he lies on the sound side he may pass the night in quiet sleep.

This symptom[1] ceases if, and when, the lesion extends to the distal portions of the lung, and all the air-spaces are filled with the products of the disease. Then there is no normal bronchial mucous surface to be irritated by the encroachment of morbid matter; there is no air beyond the limits of the lesion to be utilized to move phlegm, and so there is no cough from irritation in that quarter.

The vitality of these patients is often lowered by their failure to get sufficient sleep, because of nagging cough in the night. And the act of coughing is often harmful, since it may cause fatigue, and more or less violence to the diseased tissues, thereby increasing fibrosis. The cough is to be encouraged when it brings up phlegm, but it should be restricted to the gentlest efforts that will accomplish this purpose. The cough often tires the chest-muscles, but it does not otherwise hurt the system as a whole, and it rarely injures the larynx. But when it keeps the patient awake it is a misfortune; and when the cough is racking and harassing, as when no phlegm or very little is brought up, it sometimes provokes a hemorrhage, but rarely a large one, for the large ones only follow extreme invasion of the vessel walls by the tuberculosis; and that

[1]For a fuller account of this "symptom," see a paper by the author, entitled, "Cough Induced by Posture as a Symptom Nearly Diagnostic of Phthisis," where (so far as he knows) it was first described. *Transactions of the Association of American Physicians,* 1894, vol. ix, p. 229.

event produces large hemorrhages with or without cough.

Indigestion of various forms and degrees is a symptom of pulmonary tuberculosis, particularly where there is fever. As a result of the fever there is anorexia; most of the patients eat little, and they eat in a most erratic manner. They do not know how to eat; that is, they devour the things they like best, which are usually the foods that are least nourishing and digestible. They will take fruit that is appetizing, but little nourishing, and refuse foods that make tissue; and they eat at times and in quantity as their whims move them. Left to themselves, they rarely eat more than three times a day, usually two very slight meals, and one rather hearty meal which is never perfectly digested. In this way their digestion is disturbed and they have gastric discomfort, acidity, water-brash, occasional vomiting, and very often diarrhea. Sometimes this last is due to tuberculosis of the intestine. Sometimes it occurs in old and weak patients as a terminal complication in the pulmonary disease. Most often it is due to simple indigestion; that is, with good diet and regimen it is usually correctable.

Vomiting often occurs in pulmonary tuberculosis, and is a troublesome symptom; but it comes mostly with cough paroxysms, and means little or nothing as to the condition of the digestive function. Some-

times it is due to overloading the stomach, and a very small meal may be too much for the condition of the patient. In such cases vomiting may be remedial, like the vomiting of excess of milk by a normal baby, or like lavage in any case of dyspepsia.

In women, if the disease is contracted during menstruating life, this function usually ceases as soon as the patient becomes markedly debilitated. This is a symptom that expresses an effort of nature to save the life of the patient. It is always a misfortune when a tuberculous woman menstruates, for she has no surplus of blood to lose.

The rate of progress of this disease varies greatly. Some people with tuberculosis of the lungs go on with their business, and may recover while they are about it. They are able by their physiologic powers and forces to segregate the disease in a part of the lung, and to destroy any small number of its bacilli that get into the circulation. Others fail rapidly even when resting. They improve a little, then get worse, have an extension of the disease, with catarrhal pneumonia about the seat of it, and in a few days get up and are better again; but each time, as a rule, the improvement following these backsets is not quite so great as it was the previous time; that is, it fails to bring the patient up to his previous standard. Some of them in their partial recoveries put on weight in a remarkable man-

ner. A run-down patient goes away for a vacation; fresh air in abundance and rest soon improve him; he gains what he had lost, and gains more. From being many pounds below his normal weight he may reach ten to twenty pounds above it. Most of this is made by mere fat, but sometimes it is in a measure due to new muscle produced by athletic exercise. In either case it is always a misfortune. Over-development of fat or muscle is usually followed by a relapse of the tuberculosis, with reduced prospects of ultimate recovery.

Pulmonary consumption is often a remarkably painless disease. Patients go through the course of it and die, suffering almost no pain at all, so that some of them say, as they have many times said to me, that it is a most comfortable disease to die of. But the majority of them do have more or less pain from time to time in the walls of the chest, in the intercostal nerves or pleura, in the abdomen from indigestion, and from some of the complications late in the disease. Joint pains with swelling are not uncommon. Sometimes a patient becomes very nervous, although that is exceptional and is probably the result of personal idiosyncrasy.

I have spoken of the sputum and the things it contains — mucus, blood, granular and calcareous matter. As the lung dissolves, particles of its tissue, in the shape of curved fibers especially, are

present, and may be found by the aid of the microscope. It practically never happens that the patient expels a mass of the lung of any considerable size, although physicians sometimes fancy this to occur when shreads of buff-colored fibrin are coughed up following a hemorrhage. Once in a thousand cases perhaps a small fragment of lung-tissue is, from the spread of the disease, suddenly cut off from its base of nutrition and becomes gangrenous. Then the breath of the patient emits an intense aromatic fetor, and he may expectorate a little piece of lung-tissue with darkish fluid, with or without blood. I have never seen such a piece larger than the end of my little finger. The things that we usually find in the sputum that show that the lung is dissolving are substantially nothing but the fibrous tissue of the walls of the air-vesicles, fibers curled in various shapes that we recognize as such under the microscope. But many times, in examining sputum in progressing phthisis, we fail to find anything of this kind.

A few years ago we were taught, and believed, that fever *per se* is extremely hazardous to life. Now we know that such is not the case, and that one may tolerate fever for a long time with only moderate harm. Therefore a little increase in temperature for some hours of every day in a phthisical patient consists with fair nutrition, and some patients actu-

ally gain in weight under these conditions. I have known a patient to have fever every afternoon for a year and finally recover, and not lose very much in weight during the time. It is the thing that produces fever that often destroys life, and if this continues long enough and the influence is profound, of course it wears out the resisting power and death ensues. It is therefore the poisoning of the system by the tuberculosis and pus products, and not the fever, that destroys life in the end.

Some patients are cut off by hemorrhage and other accidents, and by various complications of the disease. In the average case, where fever occurs only a part of the day, the temperature at certain other times is likely to be subnormal; that is, it is likely to be subnormal if the patient is in a debilitated state — his vigor much depreciated. During the first six months of the disease a patient who has a good deal of physical vigor, but a little fever every afternoon, will have a normal temperature night and morning, and will not appear to fail much. Let this go on until there supervenes marked debility and some cachexia, and in the morning he will probably have a subnormal temperature to the extent of one degree or more.

It is instructive to observe that fever is always made worse by influences that put a strain on the powers of life. A patient with a temperature of

100° F. in the afternoon, when he is quiescent, will have it rise to 101° or 102° F. if he walks two or three blocks or holds a vexatious conversation or one involving a mental strain of any kind. It is therefore not true that fever is always induced solely by poisoning. In the study of fever as a pathologic process we have heretofore rather assumed that there is only one thing that produces it — namely, poisoning or infection. The experience with tuberculous patients has negatived this theory to some extent, and that experience is worth a great deal. A medical friend had for some little time a slight daily fever (not from tuberculosis, but probably from a form of malaria), and he found that by playing a round of golf or taking other active exercise his temperature would rise higher at once. The truth must be that exercise and excitement raise the temperature when the system is being poisoned by some toxin which it is trying to get rid of, but only succeeds in keeping in abeyance, and when the exercise and strain would not otherwise produce any such effect. This explains how we may save the lives of some patients by keeping them still.

The sweats of phthisis are a great trouble to the patients and their friends. There is a popular notion that night-sweats are inimical to life; and if a patient perspires a little in the night, he calls it a night-sweat and is liable to be greatly distressed

about it and, if the sweat is profuse, to insist upon having some drug to stop it at once. Most of the sweatings of these patients are slight, occurring about the head, neck, and shoulders, scarcely ever being sufficient in quantity to more than moisten the night-clothing — never enough to wet the bed. They are a matter of little consequence. There are probably a dozen medical students in every class of a hundred, who, if working hard preparing for examinations, have the same condition at night and take no notice of it. This perspiration, if it means anything at all, is a useful thing. Perspiration rids the system of poisons. The perspiration of a healthy person, if injected in small quantity beneath the skin of a little animal, will generally prove harmless; but if that of a patient with typhoid fever or some similar grave poisoning is used, the animal immediately becomes sick and may die. The colliquative sweats are a great annoyance to the patient. They make him feel disagreeable; they wet the bed, even to the mattress, give him a chilly sensation if he gets uncovered, and he is made unhappy from that condition, and more so because he thinks it is a very grave thing and may even mean death. I have seen patients recover after having this kind of a sweat every night for many months. It is unproven that the sweating does any particular harm. The patient may declare that the night-

sweats are killing him, but it is not true. The patient may be dying, but if he is, it is from the thing that causes the night-sweats. The sweat evacuates a lot of saline water as well as effete matter, and drinking-water and table-salt can easily replace the needed elements to the blood.

Every patient has more or less short-windedness, and this fact is one of the most useful hints for diagnostic purposes. It is perfectly natural that he should be short-winded, and he always is to some degree, and the annoyance from this is considerable, particularly when he exercises. Even when he passes into recovery it does not stop, but sometimes goes on progressively for a long time. It does not cease until the deposit of fibrous tissue in the lung ceases; and the fibrosis probably always continues to increase for some time after the tuberculosis is healed.

Frequently a patient is annoyed by the wheezing and rattling sounds in the chest. These are often minified or overcome by his lying on the sound side of the chest, if the disease is one-sided.

Patients nearly always become cachectic to some degree, and as the disease progresses the cachexia becomes more profound. It will come to be admitted, I think, that the cachexia should not be known by any qualifying name. I do not know how to distinguish cancer cachexia from that of tuberculo-

sis. The cachexia of pernicious anemia produces usually more of a lemon tint than the average patient with phthisis has, but not more than some consumptives have.

We hear a great deal about the "glassy eye" of phthisis. We see repeated references to it in general literature, and even in books on medicine. The appearance is spoken of as though it was an actuality and of some diagnostic value, or at least characteristic. But the eyes of consumptives are no more glassy than the eyes of other people who expose an equal amount of conjunctival surface to the effect of reflected light. In any emaciation the fat beneath the eyelids shrinks or disappears, and the eye opens a little wider than usual, and so offers a larger moist surface for reflection. This symptom, if such it may be called, has no diagnostic value under any circumstances; it is found in any emaciation.

We must always remember that in the recovery from phthisis there remain damaged organs; that the patient is always somewhat short-winded, particularly if he exercises; if he walks up stairs at the usual pace, or lifts heavy weights, it always shows. No matter how long a patient may live, the injury to the lung from the disease, the thickened connective tissue or scar-tissue, always changes the sounds of auscultation and percussion. Slight

dulness and some bronchial breathing can usually be perceived over the site of the lesion to the end of life.

I have referred to some of the complications of tuberculosis, but from the clinical standpoint some of them ought to be considered rather as natural extensions of the disease; as, for example, the tuberculosis of the larynx, in which the vocal cords, the epiglottis, and the arytenoids may be affected. But there may be congestion of the vocal cords and other laryngeal structures without ulceration or tuberculous deposits. In the severe cases of tuberculosis of the larynx there is always partial or complete aphonia, because either the vocal cords are tuberculous or the mucous membrane of the larynx is swollen at some point near them, and presses upon one or both cords and interferes with their vibration. If the arytenoid region of the larynx is much involved, there is nearly always dysphagia, sometimes to an extreme degree. Swallowing is so painful as to make starvation welcome.

Sometimes the pharynx becomes tuberculous and is studded with numerous minute whitish deposits. The diseased pharyngeal surface is always tender, and deglutition is painful. This must not be confused with the whitish appearance of follicular deposits in the tonsils. With this latter condition there may be some deep discomfort in swallowing,

but never the acute local tenderness and pain of pharyngeal tuberculosis. There will sometimes occur ulceration of the ear-drums, usually late in the disease, resulting in more or less deafness, although the patient may have no discomfort; indeed, he rarely has any with this complication, and the discharge is rarely profuse. It may, however, be fetid.

A frequent symptom is diarrhea, with more or less pain in the bowels, especially just before an evacuation. This symptom may occur both with and without tuberculosis of the intestines; more often it occurs without it and as a casual result of indigestion. This latter nearly always causes diarrhea, either by the discharge of insufficiently elaborated material from the stomach into the intestines, which directly provokes the diarrhea, or by reduced digestive power in the intestines themselves. A very common complication is some rectal trouble, as hemorrhoids and little abscesses near the anus, and resulting fistulæ. This last often gives little inconvenience or pain, but continues long; indeed, a patient rarely recovers from it while he is tuberculous. The epididymis and vas deferens are often involved; less often the testicles, bladder, kidneys, seminal vesicles, and prostate gland. And these complications are often borne for a long time with only moderate effect on the health when the lungs are but slightly diseased.

The albuminuria that comes on late in the disease is a serious thing. It may be extreme in degree, may last many months, and then decrease or disappear entirely as the lung trouble improves. In only a small proportion of the cases do we find tube-casts in the urine. In these patients there is probably always amyloid degeneration of the kidneys, which permanently impairs their functions. The liver sometimes swells, and may project down as low as the umbilicus or lower. The enlargement is uniform, there are no nodules, and no pain or serious discomfort results. This complication may, after enduring for a year or more, actually disappear, the organ returning to its normal size and leaving no sign or symptom of reduced hepatic function.

Cold abscesses occur in the subcutaneous parts occasionally, resulting probably from some injury to the deep tissues, as by a blow or squeeze that may have been forgotten. They are a complication of some gravity, but not necessarily great gravity; they are usually tuberculous, and frequently heal. Thus their presence is not inconsistent with general recovery. Meningitis as a complication always destroys life, but it does not occur often in the course of pulmonary tuberculosis. Tuberculous meningitis occurs mostly in children who have apparently no other focus of tuberculosis, although they

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usually have a hidden one somewhere, perhaps in some gland. Here the symptoms are those of meningitis in general, with all their irregularity and simulation of typhoid and other fevers.

A very common accompaniment of the pulmonary disease is pleuritis. There is some question as to whether it should be called a complication, for it is a fact that nearly always a tuberculosis of the lung causes inflammation of the pleural surfaces covering the region of the disease. In post-mortem examinations we always find adhesions in cases of advanced tuberculosis, but we never knew, until the Murphy method of treating apical tuberculosis by pleural inflation was used, how generally pleuritis and adhesions occur in the earlier stages of the disease. Now we find that the inflation treatment cannot be employed except in an early period of the disease. After the latter has continued for a few months adhesions are so extensive usually that the pleural cavity cannot be inflated. There is sometimes no pain with pleurisy, and it rarely causes pain for long. With each extension of the disease there is generally a little pain for a few days, and there may be in a given case several extensions at variable intervals. In exceptional cases there is a condition of dry pleurisy without adhesions but with abundant friction sounds, that may continue for a long time with little or no pain.

Little further need be said about general miliary tuberculosis, save that it is rare except as a terminal event in various forms of tuberculosis where the resisting power has become greatly reduced. This profound reduction in vitality invites all sorts of complications in numerous organs, and these frequently occur and lead to the death of the patient. Patients often die of diseases remote in character and location from those with which they were first attacked.

CHAPTER VII

THE PHYSICAL SIGNS OF TUBERCULOSIS

The physical signs of the chest in tuberculosis constitute a branch of the subject that might perhaps be considered entirely under the head of diagnosis. But there are some good reasons for treating it in a broader way, and many of its truths will bear repeating many times over. The physical signs are data that we discover by physical exploration, by study with unusual methods, by examining the naked chest critically and in a variety of ways. They differ very much from the symptoms, which are largely the experiences which the patient can tell about. He can tell little of his physical signs, save occasionally when they are naturally related in his mind with the symptoms, as when he hears and feels the rattling of phlegm which he is expectorating, or when he feels his heart beating in a place he knows to be abnormal.

The subject of the physical signs of the chest becomes simplified if we consider for a moment just what is meant by the terms, and what happens inside the chest in health and in disease. It is like trying to find out what is going on in the next room that we cannot see: we try to learn about it

by listening to the various sounds, including the conversation; and perhaps by various physical tests applied to the partitions and through the cracks and keyholes. The methods must necessarily be more or less indirect, and their proper execution will require judgment and carefulness always.

To begin with, there are to be observed some surface changes that are of consequence. One side of the chest expends less than the other, and we know that there is something inside that impedes its free movement; one side has fallen in a little or sunken, and we know that some disease has probably happened to cause it. Again, where the light strikes the emaciated body to make rib-shadows, we see that at the lower part of the chest some organs move up and down with respiration, but on one side they move farther than on the other; that tells us that the excursion of the diaphragm is less on the one side than on the other, which argues possible adhesion of the pleura on the side of lesser motion. Then we may see or feel the heart pulsating through the chest-wall — not where it is seen to beat ordinarily, but above it, between the second and third ribs to the left of the sternum. That tells us either that the heart is very large or that something that usually covers it has disappeared; and we remember that the heart is covered by a wedge-shaped portion of the lung, and that if this

covering were pulled away, the heart would fall against the chest-wall and be seen to beat through it. So we look for contraction of the left lung.

As an indispensable aid to physical examination of these parts we must understand and keep in mind what goes on physically in a disease of a lung like tuberculosis. Such a disease thickens the lung; then it hardens and contracts it. Hardening precedes contraction; the connective tissue thickens and hardens. The disease dissolves the tissue in places, hence cavities; it may cause the partitions between the air-vesicles to be dissolved in scattered regions, so that the air-spaces that carry on the respiration are larger than normal. There are cast into the bronchi fluid and semi-fluid substances which the moving to and fro of the air disturbs, producing various sounds called rales and rhonchi, and which substances are brought up as phlegm through the trachea by air-pressure. These changes, of course, alter the structure and function, and so the physical signs of the lung. The pleuritis is a thing outside the lung, and if effusion takes place, it compresses the organ. So, knowing that the physical condition of the lung is changed by the disease, we resort to various devices to see if we can discover through the chest-wall what is going on inside. That is the purpose of our physical examination outside the chest.

The lung in health is full of air and cannot be wholly emptied of it. And we take advantage of this fact, and use the lung as a sound-transmitting body. We test its power to transmit vibrations, those produced by (1) the inflow and outflow of air, (2) by the heart, (3) by the voice, (4) by various accidental conditions, and (5) by numerous artificial devices. We listen to the chest with various instruments or with the ear, to see if the sounds that belong to health are present or have become changed; and we have learned, by examining the chest in this way and by a study of post-mortem conditions, what changes in the lung produce certain changes in the sound. In the main, the changes in the physical signs are logical; when we come to reason about it, they are mostly, but not altogether, what we should expect with the particular pathologic conditions.

We listen to the sounds of the heart through the lungs; that tells, by their faintness or intensity, of the conditions of the transmitting lung-tissue. There are other vibratory changes that we listen for. Other evidence we get by placing the hand over the chest when the patient is speaking; that we call vocal fremitus. If you put your hand on the back of the chair that you are sitting in, you feel the vibrations that your voice makes. Vibratory impulses travel down through the bronchi and

through the lungs and solid tissues of the chest into the chair. They are intensified by some thickening of the lung-tissue. We listen for the voice and whisper with an instrument or the naked ear over various parts of the chest-surface to see if the sounds are transmitted through any part with increased or lessened force. We listen to these sounds and make these tests in the normal body and observe them in patients, and compare the two lungs of an individual with each other.

As the lungs are changed structurally, so are these signs changed. There are sounds produced by the movement of phlegm, serum, mucus, pus, and blood, by the closure and opening of channels through which air rushes. These are adventitious or unnatural sounds that we know by various names as rale and rhonchi, with many variations of description, as moist or dry, crackling or sibilant, coarse or fine, and many others. Then we measure the expansion of the chest and of the sides by comparison, and measure them at rest, and observe their motion and shape, and try to learn if any abnormality has been produced by disease.

In the practice of internal medicine we should not try to remember all the possible changes by the unaided power of memory, but should learn to apply all the tests to cases and then consider the signs and symptoms rationally, so that when certain

sounds are heard or certain signs are perceived they shall have a logical meaning and we may perceive in imagination the physical changes that cannot be seen with the eyes.

Sometimes a machine known as a spirometer is used to measure the amount of air that can be expelled from the lungs after a deep inspiration, for comparison with the supposed normal amount. This apparatus is made much of by some physicians; and if we could know as to every patient what his lung-capacity is when he is well, and then measure it when he is ill, it would prove of great value. As a matter of fact, we rarely know that, and people differ widely in the amount of air they can take in and expel. It frequently happens that a man with tuberculosis can blow more air into the spirometer than some vigorous men in health. We never expel all the air that is in our lungs; a variable amount of residual air is always left. There are some chest skeletons so constructed that they can compress the lungs more than others, and so expel more air, just as there are people with loose joints who can contort their bodies into various shapes that are impossible to others. It is what the patient can expel rather than what he can hold that the spirometer tells.

In testing for vocal fremitus, always put the two hands on corresponding regions of the two sides

of the chest; then let the patient phonate, perhaps say "ninety-nine"—that makes a maximum amount of tremor. After having done that, press the ulnar edge of the fists or of the extended hands against the chest similarly; then cross the hands and press them against reverse sides, to correct any errors in touch due to right or left-handedness. Then test the two sides successively with one hand. Whenever the fremitus is greater than normal, the tissue of the lung is, we argue, a little thickened, with patulous bronchi, and therefore the voice vibrations are transmitted more vividly; when it is less than normal, we suspect the presence of fluid in the pleural cavity, or partial or complete closure of some of the bronchi, to inhibit the vibrations. If the bronchi are filled with phlegm or obstructed, of course they cannot transmit voice vibrations and produce fremitus. It is not always safe to say that, because there appears to be reduced fremitus in a particular place, the bronchi are obstructed, since the disease may be on the other side and cause increased vibration there, which may be misleading.

We use percussion as a means of testing, in a way, the physical condition of the lungs; really we learn by it the amount of air in particular regions, and to some extent the size of the air-containing spaces. The best means of percussion, to be used when possible, is the examiner's fingers.

The best way is to press the fore and middle finger-ends firmly together and use them as a hammer, using the middle finger of the other hand as a pleximeter. One can strike a strong blow in that way. The middle finger alone is a good hammer when used expertly.

A great number of percussion instruments have been devised, many of which are useful. The best percussors are, first, a little ball of metal over which rubber is stretched, and attached to a handle; and second, a firm handle to which is attached a metallic hammer, into a hole in the striking face of which is fixed a projecting plug of rather yielding rubber. The former makes a high-pitched tone which can be produced by the gentlest blow — one that does not cause pain to the tenderest surface, even over an inflamed peritoneum; the latter produces a low-pitched tone more like that made by the finger. Each kind of percussion hammer produces tones somewhat different from every other; so if any one of them is to be used for diagnostic purposes, some practice will be necessary to learn the significance of its tones. If you percuss lightly, you will elicit sounds showing the condition of the surface of the lungs; if you strike heavy blows, you will make sounds in which the deeper organs are more or less concerned.

We make what we call auscultatory percussion by

listening with a stethoscope over the chest while percussing near it. This is rarely used and is not very valuable. But students should learn early and use often the open-mouth percussion. If you direct the patient to open his mouth wide and to breathe naturally through it without noise, and then percuss over a region of lung that is more or less infiltrated, you will find the abnormal sounds more pronounced and get a better idea of the changes in the lung. But you will not find one person in a hundred who can do this act perfectly the first time he tries, for it is a psychologic fact that a person can rarely do correctly on first trial any maneuver that involves more than a single idea, as this one does. With this method percussion over a thickened lung, in front and near the clavicle especially, elicits sounds of higher pitch than with the ordinary method. A sound that would be called dull by the ordinary method becomes flat by this. In many cases we may produce by heavy percussion over an apex, and more vividly by this method, the cracked-pot sound — a peculiar click that is not simulated by any other sound. It is brought out better by percussing with the fingers than with any machinery. The click is probably due to the striking together of the sundered surfaces within the lung, or by the sudden pulling apart of contact surfaces by the jar of the chest produced by the blow. It consists with small

cavities, with bronchi partially filled with phlegm and surrounded by nearly solid lung, and may sometimes be produced in normal children. The percussion with the open-mouth breathing is one of the most useful of all methods for testing the conditions of the upper front part of the lungs.

Sometimes the percussion tones are changed by posture. This is evidence of fluid surrounding the lung. Wherever there is such fluid there is dulness on percussion, and in a few cases the liquid in the pleural cavity is so manifest that a shaking of the patient elicits a splashing sound that may be heard some distance away.

For auscultation there are but few instruments that are useful, or that are better than the ear applied to the chest. In using a stethoscope one should test the different varieties on the market, and learn to use the one that is best adapted to his ears. There are great differences among them, and what is perfectly adapted to one person may not be used with any satisfaction by another.

The best instrument is that one which conveys to the ear most accurately the lung tones, increased in intensity, and with the least disturbance from adventitious noises. The monaural wood, hard rubber, or metallic stethoscope, with oval chest-piece and slightly concave ear-disk, is the best instrument for faithfulness of transmission and accuracy of

tone, but it is something of an art to use it, and one that many physicians never learn. More convenient to use about the patient, and withal a very satisfactory one, is a binaural instrument with tubes in part flexible and in part metallic, that, by a spring, press rather large ear-tips firmly into the ears and at the proper angle for the particular individual. A hinged spring that makes the ear-tips adjustable at any angle is a great convenience, as is also a chest-piece with reversible ends of different diameters, and fixed to the Y-shaped metallic tube with a slip-joint and devoid of screw-threads.[1]

The phonendoscope is a useful instrument when made with a firm metallic chest-box, with a large diaphragm of hard rubber slightly bulging in the center, and attached to metallic ear-tubes held steadily by a reliable spring. Thus constructed, it magnifies the chest-sounds beyond the power of any stethoscope, and preserves their qualities to a remarkable degree. In effect it takes the listening ear almost into the chest cavity. The soft-rubber ear-tubes, with no means of firm or uniform fit to the ears, that have been much exploited and used, are unphilosophical, cannot give uniform results and ought to be discarded.

Let us now consider the progressing disease in a lung and see what occurs in physical signs. The first

[1] The Ingals stethoscope.

change in the lung, as a physical medium for the transmission of vibrations, that actually occurs in most cases of tuberculosis, is a thickening of the general connective tissue of the organ, and of the bronchi with their peribronchial tissue. And it is important for us to be able to distinguish the physical signs at this early period. The first sign that would naturally be searched for is a trifling dulness on percussion. But that is not the first one that will be found. The first sign consists in changed auscultation sounds, and these are nearly always present early. Rales may and may not appear. A sudden expiration or a cough may abolish rales by carrying the mucus along the tubes toward larger diameters; or a deep inspiration may cause them to disappear by expanding the bronchi.

The first change is usually an expiratory sound a little louder and longer than normal. We speak of it as a trifle rude; that word is expressive. The tendency of one's mind is to say erroneously that it is higher in pitch. It seems so. Sometimes it is higher, but often it is not, but only louder and longer. The normal sound of expiration is a little gentle puff, which, because it is short and gentle, we are wont to say is low in pitch. When the tissues of the lung begin to thicken, the expiratory sound is usually soon heard to be slightly prolonged and louder, and so seems higher in musical pitch

than normal. Thus we have tubular or bronchial expiration, louder than the inspiratory sound, and yet in many cases the inspiratory sound is louder than normal and harsh; again, it is sometimes fainter than normal, a result sometimes of damage to the air-vesicles. If the bronchi are patulous, the fremitus is a little increased over the thickening as compared with the other side.

It must be remembered that for some reason there is, in health, over the right apex a longer expiratory sound than over the left, and therefore a little suggestion of tubular breathing. We should be careful not to confound the normal disparity between the two sides with disease of the right apex. In order to be safe and accurate, we are frequently obliged to state to the patient that in the right apex a thickening of the connective tissues *seems* to have been produced by some inflammation that has occurred some time in the past; and that whether it is a fixed exaggeration of the normal disparity between the two sides, or is pathologic, time and further evidence alone can tell.

To recapitulate, we have: Prolonged slightly tubular expiratory sound, possibly a little elevated in pitch; inspiratory sound possibly more rude, possibly suppressed to some degree; increased fremitus; no particular change in the percussion tone. These are the signs that we note in the very beginning of

an infiltration in a lung region; and we should expect to find them only slight in degree.

Let us suppose, now, that the tuberculous process has gone on to produce more marked thickening; that it is simply an extension of the condition first described. Now the fibrosis is greater, there is more thickening of the trabecular matter in the neighborhood of the region of diseased lung. The lower line of tuberculous deposit in an apex may be at the level of the second rib. The signs that have been mentioned are now simply exaggerated over the apex where the consolidation exists. But the fibrosis extends to a slight degree down perhaps to the line of the fifth rib.

You see the patient in the first two months of his sickness, and you find the few signs I have spoken of at the very apex, and possibly a few rales. At the end of another month or two, if the disease progresses, there is more thickening, indicated by more extensive tubular breathing, more adventitious noises, and less rather than more of the pure inspiratory vesicular murmur. You find now that the evidence of fibrosis has extended far below the fifth rib, and the prolonged expiration shades off at this point to the normal sounds at the bottom of the lung. Now let the process become still more extended and many of the air-vesicles filled with the products of the disease,the bronchi perhaps narrowed

a little by the pressure of the contracting fibrosis (for the fibrous deposit always contracts as it grows old), and there is reduced resonance and elevation of pitch on percussion, otherwise dulness, or, if the condition is extreme, flatness. There are few or many rales, depending on the amount of fluid discharged into the bronchi.

Now, perhaps, little cavities begin to form in the apex, giving a gurgling sound as the patient breathes, and, if they get larger, the amphoric sound of true empty cavities. When there is distinct percussion dulness or flatness, with patulous bronchi, there is a peculiar expiratory sound that is always important to be distinguished. It is a loud, prolonged, often rather hissing expiratory sound of high pitch, the sound appearing to be near the ear, while the inspiratory tone is shorter and fainter and devoid of the quality of true vesicular murmur. This is the true extreme bronchial breathing, and is exactly what you hear in an ordinary lobar pneumonia over the region of consolidation; you hear it also early in pleuro-pneumonia. In such cases, sometimes before you can distinguish any change by percussion, you will be able to elicit this tubular sound by auscultation. Once heard, it can never be forgotten, and its meaning is invariable that the lung is consolidated around patulous bronchial tubes.

If there befalls a large cavity that is full of liquid,

it fails to change distinctively the lung sounds by auscultation,or by percussion save to increase slightly the dulness. If it becomes empty and its walls are thick enough or the surrounding tissue firm enough to prevent collapse, we may hear the amphoric sound, like that produced by blowing across the open mouth of a bottle.

Now suppose, as happens not infrequently, that the fibrosis does not occur uniformly over the diseased area, but presses sharply upon some localized part of a large bronchus; or suppose some of the lymphatic glands swell and make such pressure: we shall then hear exactly the sound that is produced when a large goiter presses against the windpipe. It is a tubular sound, very loud, and simulates somewhat the sound heard when a stethoscope is placed over the normal trachea. The same kind of a tone is in rare instances found to be due to localized tumors of the lungs — chiefly cancer and sarcoma.

As to the sounds produced by moving air in contact with phlegm in the lungs, the variations are almost limitless. We have numerous kinds of rales and rhonchi. Some we call dry rales, because they do not suggest fluid; if a bronchus is collapsed at some point, or a little bunch of thick phlegm obstructs it, there results the sibilant or whistling rale. The air churns the semi-fluid material in the tubes, producing moist rales; these sounds are

sometimes aptly described as gurgling. Another descriptive and very good term is crackling rales, the phlegm having become so thick and sticky that when it is moved by the breath, crackling sounds are produced. We must remember that all the sounds produced by phlegm are things that come and go, and that we may find any such sort of a rale to-day and none to-morrow.

We often hear over a tuberculous lung the friction sounds of pleural rubbing. The sound produced by the slight movement upon each other of the palms pressed together firmly over your ear is a good illustration of these tones. Of course, when fluid is present in the pleural cavity, there can be no friction sounds, but dulness on percussion. Sometimes when the patient changes his posture the upper line of flatness changes if there is fluid, but often it does not change, owing to encapsulation. Over a mass of fluid or air or gas in the pleural cavity the vocal fremitus is lost, whereas over a partially consolidated lung, where the bronchi are open, the fremitus is always increased. We should avoid falling into the rather common error of thinking, simply because there is flatness with some rales in the lower part of a chest, that there is certainly consolidation of the lung-tissue instead of fluid. When much fluid is present, the lung sounds are so distant that they are hardly perceived unless the pleural cavity is

severely distended; then faint bronchial and even lung tones may be transmitted through it.

The voice and whisper signs are interesting in tuberculosis. They are not especially valuable in late cases: the value of the voice signs is early. When a point is reached where pectoriloquy is obtained, it is simply a curiosity. At this stage of a case usually other signs have already established the diagnosis. Bronchophony is a very valuable sign, but valuable at the beginning. Whenever there is increased fremitus, the voice signs are usually increased, and this is a valuable confirmatory indication.

There are certain obstacles to learning these physical signs that we need to study in a practical way. You will find very soon that the average patient does not know how to breathe for you to listen, and when making an examination your calling his attention to this function fixes his mind on the performance so that he ceases to breathe naturally. If your ears are acute to slight variations of sound, you are liable to become confused by some adventitious tones. The chief trouble is with the muscle tones. Because he thinks he is breathing for you to listen, the patient may take deep breaths and not sufficiently expel the air, and use twice the muscular power necessary. A muscle in the act of contracting always produces a slight continuous humming noise

that can be heard with the stethoscope. It is a sound that you cannot locate, but you will recognize it as a muscle tone, and know that the patient is using some muscles about the chest, and using muscle power not necessary for respiration.

Many patients, when breathing for you, will be unable to breathe normally; they will breathe violently, with unusual force; they cannot be tranquil about it. When properly auscultating a chest, it is necessary that every muscle about it not needed for respiration shall be absolutely at rest. When you enjoin this upon patients you will many times find it impossible for them to obey; the harder they try not to have the muscles tense, the more they fail to succeed. You may sometimes counteract this tendency by diverting the attention away from the act of breathing. Have the patient lie down on his back, turn on his sides alternately, and on the abdomen while you listen over his back; have him stand and bend his body forward. These changes of posture will sometimes cause him to forget completely that he is breathing. Then you can hear the chest sounds most perfectly. Deep inspirations with shallow expirations is a frequent and troublesome fault of breathing on the part of a patient who is impressed with the fact that you are listening to his chest. This trick so distends the air-spaces of all kinds as often to abolish rales and

bronchial breathing. Then the patient should be asked to expire profoundly and to cough at the end of such an expiration. This maneuver partially collapses the air-spaces and bronchi and nearly always elicits rales if anything can, and brings out the full degree of bronchial breathing. Any patient, by the fault of breathing I have described, thereby increasing above the normal his residual air, can effectually hide from the most careful auscultator both rales and bronchial breathing of moderate degree. The examiner must be watchful and detect this usually unwitting deception on the part of the patient, and correct its errors.

The lung sounds heard by auscultation are liable to differ to a very considerable degree, depending on whether the patient is breathing through the mouth or the nose; and this difference is sometimes as marked over the back as over the front of the chest. Several times I have, while listening over the apices, heard what appeared to be a distinct bronchial tone that was wholly produced by open-mouth breathing and which disappeared the moment the patient began to breathe through the nose.

CHAPTER VIII

THE DIAGNOSIS OF TUBERCULOSIS

For purposes of diagnosis as well as for treatment, it is important to make, at the first examination of every case, a careful record of the local findings and of the general physical and symptomatic conditions, as well as the history of the case from the beginning. Then subsequent examinations, the results of which should also be recorded, will show the progress of the disease for better of for worse. No less precise method than this is to be commended. The practice followed by some physicians of trying to remember the conditions from time to time of all their chest cases is a loose and reprehensible custom. It begets unscientific habits of mind that are sure in the end to tell against the interests of patients; and it leads to many blunders in prescribing.

Many methods of case-taking and recording have been devised, and various charts and blanks have been recommended. But the most useful for the painstaking physician is, I believe, a plain piece of paper with outline drawings of the human body, especially of the chest, on which, by various marks and characters, the pathologic findings may be re-

corded. So simple a scheme as this is, I am sure, far better than some of the complicated record charts now in use. The accompanying cut (Fig. 2) illustrates the chart used by the author, with signs to indicate the various more common changes of disease. It is not offered as anything perfect, but simply as a useful tool which any one may vary.

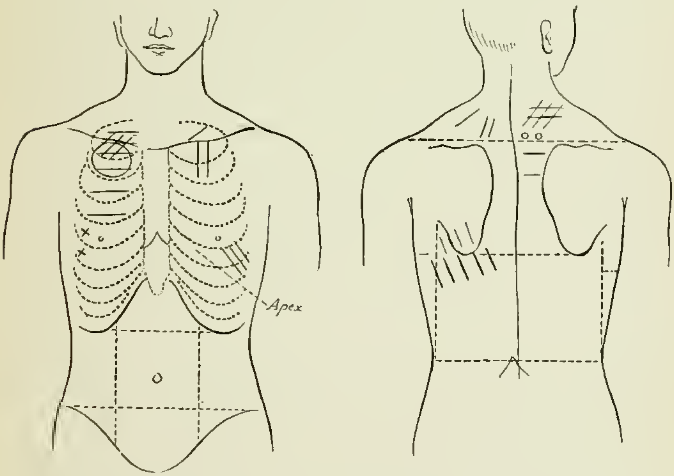


Fig. 2.—Author's chart with illustrative markings.

// Bronchial breathing and dulness, marked. Increased voice, whisper, and vocal fremitus.
═ Reduced vesicular murmur.
|| Rales, mostly moist.
\\\ Flatness on percussion, with reduced fremitus and absence of lung sounds.
O Cracked-pot sound on percussion with open-mouth breathing. Amphoric sound moderate.
oo Faint and distant amphoric sound.
xx Frictions.

The intensity of the signs is in proportion to the heaviness and the number of strokes or marks.

In the care of the sick there are few things of more importance than the early discovery of tuberculosis; for early diagnosis makes possible the most effective treatment—which is early treatment—and if made in every instance, it would lead to a great increase in the already large percentage of recoveries from this disease.

But we never can expect to make early diagnoses until we appreciate a truth that is usually overlooked — namely, that tuberculosis, especially in the lungs, always exists for a considerable time before it announces itself by signs or symptoms. It is sometimes present for a long time before symptoms appear, and our only proper course is to be alert for the first hint of any evidence that can point to its existence.

Probably it can never be known positively, but there is little reason to doubt that tuberculosis may exist in the walls of the bronchi for weeks before it induces enough irritation to cause noticeable cough; and it may exist a very long time before any conscious local irritation is produced. It must be rare that marked fever occurs — if it occurs at all — until some degree of mixed infection has been produced by suppuration at the point of lesion. This last event often occurs through some broken surface, some ulceration of the bronchial mucous membrane produced by the increase of the superficial

tubercles which are cut off from efficient blood-supply. Before pus-formation the only general symptoms would be some slight depreciation of the vital powers — perhaps some lowering of the weight and some sensations of fatigue on exercise.

Tuberculosis of the lungs is prolific in simulations of other diseases, and when the ideal signs in the chest are absent, we are frequently in great perplexity. The disease then sometimes resembles tuberculous meningitis and mild typhoid fever; it frequently simulates mild malarial fever; it resembles fevers produced by slow infection through some pus focus, or a leaking cyst somewhere in the body that produces no local signs. When focal signs are absent, we must hunt for evidence pointing to the correct diagnosis. Loss of weight, debility, cough, and indigestion should always lead to the suspicion of tuberculosis, and in every case of prolonged low fever we should promptly suspect this form of infection. It is the most common of all diseases producing long-continued fever, and we should never study a case of the latter without considering the possibility of tuberculosis. We sometimes forget this when there are no focal signs; and where there is a history of cough extending over a considerable time, we sometimes guess the case to be one of simple bronchitis.

I wish to refer again to the rather valueless char-

acter of the percussion tones early in the disease. If the disease were always unilateral, and if we could be sure that the air-vesicles had before possessed the same physical characters in the two lungs, and if we all had musical ears and could discriminate sharply as to pitch, resonance, and quality of tone, then percussion early would be valuable. Late in the disease it is always valuable; but early it is often misleading, and has differing significations to different examiners, as determined by their varying degree of expertness in tone. In incipient cases there is always abundant resonance, and physicians often make the mistake of assuming that there is no lung disease because there is no dulness or other change perceptible on percussion. The average person is a poor judge of minute changes in percussion pitch. Take a case where you suppose you have on one side distinct elevation in pitch or slight dulness; then have a musical expert come in and listen to your percussion, and see him correct your reckoning! He will probably say that your supposed higher tone has the same pitch as that of the well side, the only difference being one of quality. I would give a hundredfold more for a careful study of the changed expiratory sound on auscultation, as showing the beginning of tuberculosis, than for any slight change in the percussion signs. If some of the air-vesicles near the diseased area happen to

be dilated, the cause of dulness that otherwise would exist is neutralized; but disease signs still appear in the auscultation, especially if it is practised with various kinds and degrees of breathing.

We often fail to make a critical examination of both sides of the chest. We should always do this for comparison, and take time to do it well. It is never enough to listen to one side where the disease is supposed to be. We should listen on the two sides alternately, traversing with the stethoscope from apex to base of both lungs, the patient meanwhile breathing deeply (especially expiring fully) at our direction, and note any difference between the two sides,— note where it is, and its character and degree. If there is thickening in the apex, there is sure to be at the top a more distinct and longer expiratory tone and increased fremitus, both of which shade off to normal conditions lower down the lung. In regions where the expiratory sound is a little louder and longer than normal, the vesicular murmur on inspiration is also usually somewhat lessened. These signs mean a thickening of the connective tissue of the lung where the changed breathing exists — a change due to some disease process still going on or that has existed at some previous time.

In searching for slight changes, in cases where the disease is beginning, we must not only note the

differences as we hear them under the usual conditions of respiration, but the patient must exhale forcefully and cough at the end of such an expiration, to show what differences can be demonstrated between different parts, and to demonstrate rales that otherwise might be hidden. Where the relative difference is greatest, whether at the top or the bottom of the lung, there is the focus of the disease, and the signs shade off toward the other parts of the organ. You listen at the bottom of both lungs and find the tones exactly alike; listen a little higher, and the tones of both inspiration and expiration become slightly different in the two lungs; go up toward the top, and the expiratory sound is perhaps distinctly tubular, with reduced vesicular murmur on one side while there are normal tones on the other. This positively locates the focus of disease at the top.

We not infrequently find a slight lessening of the vesicular murmur with possible slight increase in fremitus over a whole lung and uniformly, and no other sign. For this demonstration the back is perhaps the best place to listen, although the difference can be made out on the sides; it is less easily found in front. The changes referred to mean that some disease, perhaps at some long previous time, has involved the whole surface of the lung and left its effects as a permanent condition. Pleuritis is the

disease that most often produces this effect. When a patient comes to you with vague chest symptoms, and you find the vesicular murmur slightly lessened all over one lung, with slightly increased fremitus and no physical signs besides, you may say with a considerable degree of certainty that a general pleuritis has occurred at some previous time. The patient may promptly confirm this, or perhaps at first deny it, then remember that he did have a pleurisy several years before. Pleurisy unconnected with lung disease is likely to involve the whole covering of the lung or a large part of it. It always leaves a little thickening of the surface of the lung as well as the pleura, so that ever afterward there is a slight reduction in the vesicular murmur over the region. Now, it happens occasionally that you find tuberculosis in the other lung — a condition of things that is very confusing; for there are then the focal signs of a deposit on one side, and uniform reduction in vesicular murmur over the other. This makes it seem as though the tuberculosis had actually increased the vesicular murmur over the whole of the infected lung.

It is usually easy to demonstrate in a lung the presence of a cavity of large size if it is empty and connected with a bronchus; but small cavities often exist for months without producing any sign whatever. Amphoric sound depends on a cavity of some

size open to the movement of air into and out of it or across its open mouth. A cavity of moderate size might contain air, but might have its opening into the bronchus closed at the moment of auscultation, and there would be no amphoric sound. And the tympanic percussion tone of a cavity is never produced by a small excavation or by one full of fluid — but flatness is more likely instead.

A number of physicians think they can demonstrate cavities where, I am sure, none exist. The pure and ideal tubular breathing is sometimes mistaken for evidence of a cavity; or it is this sound with coarse rhonchi, or the latter alone, or some other and perhaps unusual tone that is similarly far removed from the amphoric breathing and voice, that is seized upon as proof of cavity. On the other hand, small cavities, and many of them at once, often exist and give no evidence of their presence except, perhaps, by gurgling rales.

Sometimes loud rales and rhonchi confined to one lung are transmitted through the large bronchi to the other lung, and give an impression to the auscultator that it also is diseased. This mistake is not infrequent, and sometimes seems almost unavoidable. But the illusion can usually be detected by first noting carefully the character of the rales in the lung known to be diseased, and then tracing them toward the other lung step by step with the

stethoscope. If the rate and character of the rales and their relation to the acts of inspiration and expiration remain the same on receding from the diseased lung,— if the only change is merely a growing faintness of tone,— we may be sure the sounds are transmitted. If, on the other hand, the character and relation change, then the sounds originate in the other lung, and both organs are diseased.

The presence of the curved fibers of the walls of the air-vesicles in the sputum is of some, but not great diagnostic importance, for it rarely reveals much evidence that cannot be found by auscultation and percussion. It does, indeed, tell of the melting away of some of the air-vesicle walls; but this may occur from any ulceration besides that of tuberculosis, and when it is due to this disease, considerable fibrosis nearly always is present. The examination for the fibres is not difficult to make. Boiling the sputum in a solution of caustic soda for a few minutes makes it quite liquid; then it may be diluted with cold water, and sedimented by standing in a conical glass or by means of the centrifuge; then a drop of the sediment is placed under the microscope with a low power, and the fibers appear.

It is not safe to say that a patient has tuberculosis of the lungs because he has any or all the chest signs so common to phthisis. For there are cases — rare, indeed, but they exist — of non-tuberculous

phthisis that almost perfectly simulate the tuberculous. Therefore it is necessary to search the sputum for bacilli in every case. Once found they should never be expected to disappear so long as purulent expectoration continues, unless this comes from the inside of an old cavity.

The differentiation of tuberculosis and typhoid fever ought not to be difficult or long delayed, for in the latter condition we have almost invariably, after eight days, the positive result of the Widal blood reaction, so that the test of time and the microscope very soon mark the line between these two diseases. Malarial fever can be told by finding the plasmodia in the blood with the microscope; and any practitioner with a good instrument can learn to make the examination. Fever states due to local disease sometimes present more difficulty, but the focus nearly always gives some other sign or symptom besides fever that points to it. Where a fever continues with cough and expectoration, and especially if the slightest change can be detected in the lung, we should always regard tuberculosis as more than half proven.

The tuberculin test for the presence of tuberculosis is a safe and relatively reliable procedure to be resorted to in cases of doubt. We can inject hypodermically from 1 to 5 milligrams, starting with not more than 2 (1 is better), and if tuberculosis is

present, the temperature will rise two to three degrees above its usual maximum, beginning in a variable period of four to twelve hours, and continuing from four to thirty hours. There will be some of the usual symptoms of a febrile attack, as chilliness at the onset of the fever, headache, general pain, restlessness, possibly nausea, weakness, and rapid pulse.[1] As the fever subsides all these symptoms will gradually disappear. If there is no reaction after the first injection, it may be repeated once or twice at intervals of a few days. The second dose may be double the first, and so on for three or four doses, the last being 8 or 10 milligrams. If then no febrile reaction results, we may conclude with a fair degree of certainty that tuberculosis does not exist.

There may be congestion and swelling of the diseased regions as a local reaction to the tuberculin. This occurs in conjunction with the general reaction of fever, and may be observed readily in tuberculous skin, glands, joints, and larynx, but is not as easily made out by auscultation and percussion in

[1] Dr. C. M. Wood, formerly in charge of the Hospital for Consumptives in Chicago, formulates the following tests of a perfect reaction from tuberculin.

1. The rise in temperature must amount to at least two degrees.

2. It must reach its height between six and twenty-four hours after the injection, except in fibroid cases, where it may be delayed thirty-six hours.

3. It must be accompanied by at least two of the following symptoms: Chilliness, headache, nausea, and muscular pains.

the affected areas of the lung. It undoubtedly occurs in all internal forms of the disease.

In using this test, great care should be taken to get reliable lymph. The test should not be attempted on febrile cases, but only on those whose temperature, if at all above normal, is but slightly so, and constant for many days together. In making the test the temperature should be taken every two hours for a day before the injection and as often for a day afterward, in order to be sure of the precise effect of the procedure.

A few years ago many physicians suspected that injections of tuberculin might cause an extension of the disease throughout the body. This fear no longer prevails, and no such result follows its use. The fact of the local reaction to tuberculin has encouraged the fear of the spread of the disease; but with the tentative dosage advised, and the slight local change resulting, there is probably no danger at all, even if a profound reaction were capable of doing harm. And, even assuming a marked reaction, it is not all certain that it could set free into the circulation swarms of bacilli without which no extension can occur. The local reaction is a congestive process about the focus of the disease, and may, for all we know, be restrictive of the bacilli and actually prevent their dissemination. Moreover, the presence of a small quantity of tuberculin

in the blood (and with any fair vigor of system) must logically be expected to beget some power or thing that acts the part of an antitoxin to tubercle bacilli, rather than to encourage their growth.

Syphilis occasionally gives a febrile reaction to tuberculin; and a reaction may possibly occur from a very large dose injected into a healthy person. On the other hand, reaction sometimes fails to occur, even from a liberal dose, in an advanced case of consumption. These drawbacks only slightly impair the value of the tuberculin test, for its percentage of failures in early cases and with proper dosage is very small. And it is in the incipiency of the disease that the test is most useful.

In making the injections, aseptic precautions should be strictly observed, as well as care for the size of the dose. Tuberculin properly prepared is of uniform strength and will keep almost indefinitely. For convenience in using, it may be diluted to a 10 per cent. solution in distilled water containing 2-5 per cent. of carbolic acid — a solution that also keeps indefinitely. At the time of administration a 1 per cent. solution may be made by diluting the first solution to tenfold with distilled water; this represents 1 milligram of tuberculin in 1½ minims.

One of the latest discoveries is that the blood-serum of tuberculous patients actually agglutinates

the bacilli of tuberculosis. It causes them to gather together in clumps, as is the case in the Widal reaction of typhoid fever. Certain other diseases have the same peculiarity; that is, the blood-serum of a person who has had the disease destroys pure cultures of the causing bacilli. Thus it has been demonstrated that the Bacillus dysenteriæ, causing the dysentery of the West Indies and the Philippines, in pure culture is agglutinated by the blood of the patient; so the Widal method is not restricted to typhoid fever. I should say that this agglutination by the serum in tuberculous cases is no more reliable than the tuberculin injection in any case, and is probably much less reliable in the slight cases where the diagnosis is doubtful.

The cases of joint, bone, gland, and skin tuberculosis are all announced by symptoms and signs that are more or less distinctly focal. Many of these affections are surgical in their character, and I shall not discuss them at length here. I wish to say, however, that where the joints, bones, or tendon-sheaths are involved in any lesion that produces pain, tenderness, or swelling, we should always suspect tuberculosis, whether it exists in the lungs or not; for this infection frequently produces such lesions. Of course, if one of these lesions occurs in the course of a lung tuberculosis, we would more naturally think of it. Frequently we fail to

think of it if the lungs are not evidently diseased and if the patient is not physically debilitated. In susceptible subjects a blow or other violence is likely at any time to lower the vitality of one of these parts so that tuberculosis may supervene.

Tuberculous meningitis requires special study for diagnosis, because it differs in many ways from other forms of tuberculosis. It occurs mostly in a class of young patients who are wanting in any easily discoverable evidence of infection of the lungs or of any other part of the body. It occasionally comes as a late phenomenon in lung cases, and then we have no difficulty in diagnosis. Children have tuberculous meningitis more often than adults, and with them it often appears as an apparently initial lesion. There is evidence that the bacilli, entering the blood from some previously existing focus of tuberculosis, are carried to the meninges, and at the base of the brain find their way through the capillaries and light up the disease. It produces a set of symptoms that are the most amazing of any to be found in all the practice of medicine, because they are so irregular and so atypic.

It is impossible to describe a case of tuberculous meningitis so that one's first case of the disease shall surely tally with that description. Pain is one of the first symptoms, but it does not always appear; it usually comes early, but sometimes not until late

in the disease. It occurs usually as an irregular sharp pain in the head, but sometimes it is a prolonged, disagreeable ache. Sometimes the head is drawn back in opisthotonos, and then the meninges of the spinal cord are involved; but this symptom is usually absent.

Fever always occurs some time during the course of the disease; usually it begins as a trifling elevation of temperature, and each successive day, for a number of days, it rises exactly as in the so-called classical typhoid fever. Sometimes, however, the fever is entirely irregular; it may occur as a quick explosion, the temperature rising rapidly and remaining for a day or two as in remittent fever or the initial fever of measles or scarlet fever; then it subsides, and for a time the patient seems to be convalescent so far as the fever is concerned; then the fever returns.

The appetite is lost, the patient may vomit occasionally, or for a brief period he may eat voraciously and digest his food. He usually has constipation, but not always. These general symptoms are extremely perplexing. There is not one of them that points very positively toward the brain, except it be the pain. That, indeed, does happen in the brain disease; but children frequently have pain in the head with other diseases. They have migraines like adults, and great pain in the head with various

trifling ailments, and there is nothing surprising about it. So it happens that this disease in the early stages is very frequently taken for other affections. Probably it is most commonly taken for typhoid fever. This error is sometimes unavoidable during the first few days, but never after eight or ten days; and cases of tuberculous meningitis may last a week or ten days before focal symptoms appear. After a case has continued for ten days, the Widal test should settle the question as to typhoid fever.

The patient with tuberculous meningitis loses weight rapidly, but not more rapidly than is often the case in typhoid fever. In a few days, however, usually from four to ten, general symptoms occur that point unmistakably to the cerebrum. One of these is strabismus, convergent usually, but sometimes divergent. The pupils become unequal in size. That does not prove meningitis, because sometimes people in ordinary health have one pupil larger than the other as a result of fatigue; but with other symptoms it may be a valuable sign. In meningitis the pupils become later immobile. That always reveals brain disease.

Then the pulse becomes irregular, showing that the regulating machinery of the heart, that manifests itself through the pneumogastric nerve, is regulating the rate imperfectly; the pulse is rapid, then

slow. It does not drop a beat occasionally, as in functional disorders of the heart, but is slow and fast alternately. Then if we draw the finger-nail over the skin of the abdomen, we find that the red line produced by it appears and disappears slowly if the case is one of tuberculous meningitis. This is what is known as cerebral or meningeal tache, and is a sign of some, but not great, diagnostic value, since it appears in other conditions. It is a result of vaso-motor paresis.

The abdomen becomes flat, and then sinks late in the disease. Finally the patient ceases to be able to vomit, and refuses to take food unless forced to; he frequently emits a little whine or cry, and he is always unconscious, and therefore wholly insensible of suffering. Various distortions of his body may occur. One of the limbs may be drawn up in spasm, or the eyes may be drawn to one side.

A valuable diagnostic pointer in this late stage of the disease is lumbar puncture — puncturing the lumbar region of the spinal canal with a tubular needle. In meningitis there is an excessive amount of spinal fluid,— really an excess of cerebro-spinal fluid, for the fluid in the subarachnoid space connects with that of the spinal canal. For this operation all that is needed is a hypodermic syringe with a long needle, or a small detached aspirating needle. All ordinary aseptic precautions should be taken

with instruments, hands, and field of operation. The patient should sit or lie with the body bent slightly forward, and the needle should be held in such a way as to prevent its being plunged in too deeply. Three-quarters of an inch for a child is a sufficient depth usually; twice as much for an adult. The needle should be inserted slightly to one side of the spines of the vertebræ, and be pushed carefully upward and inward toward the spinal canal. The point of election is below the second or third lumbar vertebra. If there is an excess of spinal fluid, it will be drawn into the syringe, or will drop from the needle if this is detached from the syringe. In this manner a dram or two of the fluid may be drawn in a case of meningitis. The fluid may be clear and almost colorless, or opalescent from pus or leukocytes, or it may contain particles of fibrinous material or blood. In tuberculous meningitis bacilli may often be found in the fluid by staining the sediment procured by the centrifuge.

Of cases of tuberculous pleuritis little need be said. We cannot tell the tuberculous from the non-tuberculous. Some insist that the cases are all tuberculous, which is not true, though the majority doubtless are so. The physical signs are simply those of pleurisy. Whether the deposit in the pleural cavity is in the shape of firm or pasty material that makes friction, or organized material that fin-

ally compresses the lung, or whether it is serum or pus,—if there is much of it, it will produce dulness on percussion, the degree depending on the amount of it. It will lessen or abolish the vesicular murmur of the lung beneath it. If a chest cavity is so full of serum or pus as to put it upon the stretch, it will transmit vibratory impulses. Then distant faint breath-sounds from the lung above or from the opposite side may be heard. This is a prolific source of error on the part of students and young practitioners. They discover percussion flatness, but because they hear the lung sounds even faintly, they forget about the condition of the intercostal spaces, the situation of the heart, and the fremitus, and conclude that the case cannot be one of fluid in the pleura.

When fluid is present in any considerable amount, the intercostal spaces are sure to be less sunken than normal; they are more full, although very rarely bulging. This intercostal space sign is nearly diagnostic of the presence of fluid. A tumor may cause the dulness and lack of fremitus, and even displace the heart, but it is rarely of sufficient size to spread over a surface extensive enough to produce a uniform bulging of the spaces. In case of any degree of doubt, one should always explore the chest-cavity with a large aseptic hypodermic needle, and, if possible, procure some of the contents. This

will usually clear up the diagnosis. We should be careful that the syringe works and will make suction, and that the skin is surgically clean. With relative absence of fremitus and of lung sounds (or the remoteness of them from the ear), short-windedness, and the displacement of the heart, in addition to the intercostal sign, the diagnosis should be plain.

If the effusion is on the left side, the heart is pressed to the right, and vice versa. The first suspicion should always be that the displacement of the heart is due to pressure; it may be due to contraction. But the apex beat may be moved by enlargement of the heart, and with no disease of the pleura or of the heart-valves or portals. Then, of course, the urine should be examined for fibroid disease of the kidneys — a condition that is always attended with arterio-fibrosis. We should never regard as complete the examination of a patient who has flat percussion sound over the lower part of one side of the chest, until we have made the needle puncture. It cannot always be done, but its omission sometimes leads to humiliating errors in diagnosis. Under the safeguarding of surgical cleanliness it is a harmless procedure, and, properly done, it is substantially painless. The best way to do it is to press a forefinger firmly into the proper intercostal space, the palmar surface being downward

and pressed more against the lower rib; then to plunge the needle boldly into the chest, sliding it over the finger nail as a guide. The pressure of the finger obtunds or diverts the sensibility of the part so much that the prick of the needle is often not felt at all.

The X-ray is of some, but not great, value in the diagnosis of chest diseases. It reveals slight shading over regions of lung that are deeply infiltrated with tuberculosis, when seen by the fluoroscope; it is less satisfactory when studied by the radiograph. The motions of the heart can be seen by the fluoroscope, and the movements of the diaphragm. But the necessary apparatus is costly, and difficult to use, and it reveals little or nothing that cannot be demonstrated by the usual exploration that is within the reach and capacity of every physician.

CHAPTER IX

THE PROGNOSIS OF TUBERCULOSIS

THE prognosis of tuberculosis is of the greatest importance both to the individual and to the public. Will this patient get well? What is the prospect of recovery? These are intense questions daily asked of the physician. Years ago a patient with tuberculosis of the lungs was supposed to be doomed to die. It was thought then that relatively fewer people have the disease. Now we know that at least half of all the people have it some time, and that a large proportion of them recover entirely, while in a vast number the focus of disease becomes encysted and harmless.

As to the morbidity of the disease, some pathologists hold that 70 per cent. of all people have tuberculosis somewhere in their bodies, some time in their lives; others put it as low as 40 per cent. I think we may safely say that half the people have tuberculosis somewhere, some time. It shows strikingly the prevalence of this disease that Chicago in forty-two years lost 39,000 people from the pulmonary form. The disease kills 30 times as many people as variola and scarlet fever together, 16 times as many as typhoid fever, 8 times as many as diphtheria, and

4.5 times as many as all combined. In New South Wales, in twelve years, 72 per cent. of all deaths from tuberculosis were from phthisis, and 7.7 per cent. were due to tuberculous meningitis. During the same time the deaths from the six chief zymotic diseases were only 75 per cent. as many as died from tuberculosis. In Ireland, in 1895-97 inclusive, the mortality from tuberculosis was 11.5 per cent. of all deaths, which were 17.3 per thousand of population per annum.

The mortality increases irregularly with age, and yet hardly any one would suppose so. The popular belief is that, in proportion to their number, young people suffer more deaths from tuberculosis than older people; yet it has been found by earlier census reports, that there are more between sixty and seventy years of age. In proportion to the living, deaths from tuberculosis are more frequent between those years than in any other time of life — showing, probably, that lowering of vitality by work, age, other diseases, and the vicissitudes of life and of seasons invites phthisis and makes recovery from it impossible. These statements do not even hint at the proportion of deaths to the *cases* of the disease.

The last census reports of the United States show that the proportion of deaths was greatest between 70 and 80 years, the mortality from phthisis being

during that decade 1.91 times greater than the proportion of the living at that age; while at the age of the greatest mortality in proportion to all deaths from the disease — 20 to 30 years — the ratio was only 1.59. The following table and Chart I show the proportion of deaths from consumption at different ages, and the proportion of the living at the same ages, in percentages of the whole population. Chart II shows how the fluctuations in the deaths from the disease at different ages compare with the proportion of the living at the same ages.

This information from the census as to deaths is interesting and instructive. It is greatly to be regretted that we have no means of knowing the proportion of people at the different ages who acquire the disease, as well as that of those who die of it.

It will be observed that at no time of life do the deaths from consumption correspond exactly with the proportion of living people of the same age. Except during the first four half-decades of life, the proportion of deaths from this disease to all the deaths from it is far above the proportion of people living at the same ages, save during the two half-decades from 45 to 54 inclusive.

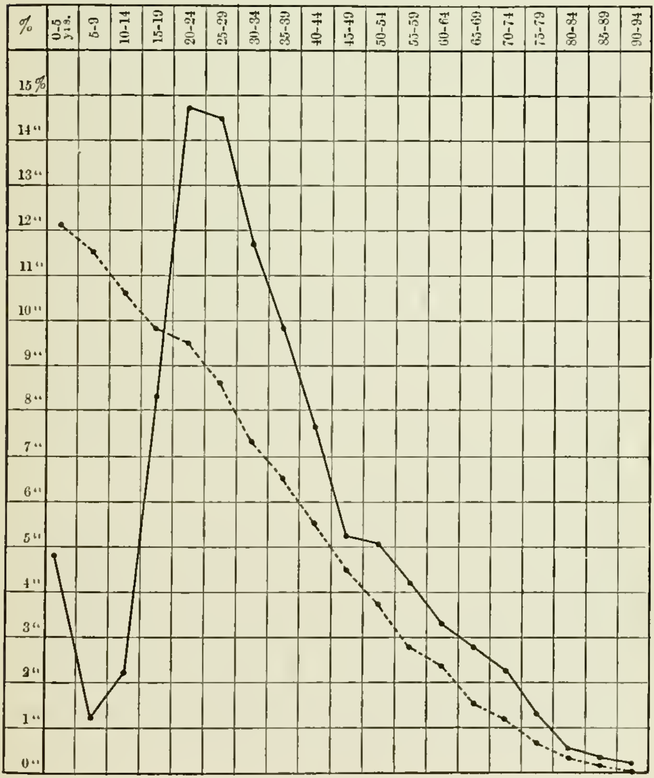
Table showing deaths from Consumption at certain ages, in percentages of the total deaths from this disease, and the proportion of living persons at the ages shown, in percentages of the whole population. Compiled from United States Census Reports, 1900.

Ages in half decades....	Percentage of deaths, etc....	Percentage of living, etc....	Ages in half decades....	Percentage of living, etc....	Percentage of deaths, etc....
Under 5......	4.08	12.07	50 to 54......	5.01	3.87
5 to 9......	1.18	11.68	55 to 59......	4.06	2.91
10 to 14......	2.12	10.63	60 to 64......	3.35	2.35
15 to 19......	8.35	9.95	65 to 69......	2.93	1.71
20 to 24......	14.71	9.72	70 to 74......	2.19	1.16
25 to 29......	14.51	8.65	75 to 79......	1.33	.68
30 to 34......	11.75	7.34	80 to 84......	.56	.33
35 to 39......	9.98	6.55	85 to 89......	.19	.11
40 to 44......	7.68	5.60	90 to 95......	.044	.03
45 to 49......	5.25	4.55			

CHART I.

Showing the deaths from Consumption at different ages, in percentages of the total deaths from this disease; also the proportion of the living at these ages, in percentages of the whole population. Compiled from Reports of the United States Census of 1900.

Solid line, deaths; dotted line, population.



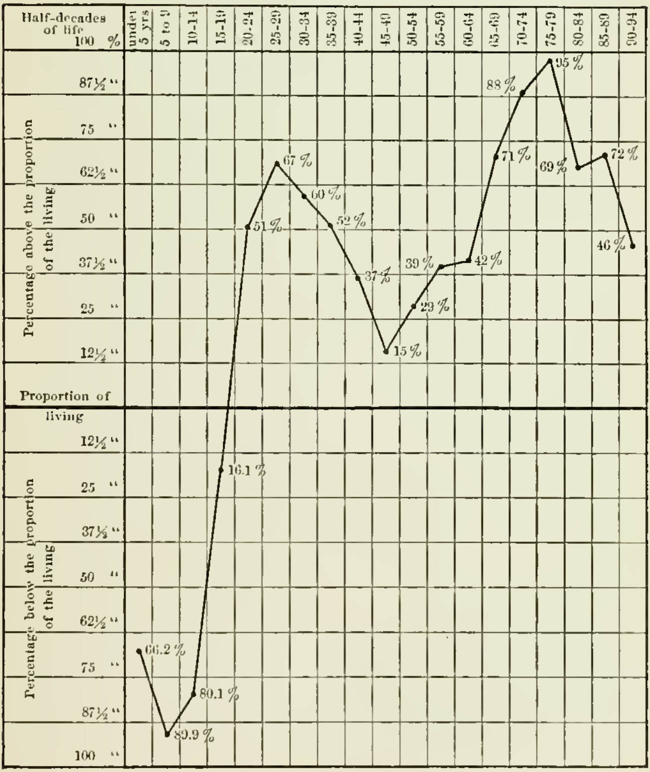
The records of post-mortems in late years are surprising. Out of 3067 autopsies, it was found that 41.86 per cent. had tuberculous lung lesions, and in 11.97 per cent. these lesion were healed, or 28.5 per cent. of all the tuberculous cases. Of 826 bodies where death was due to acute non-tuberculous diseases or to accidents, tuberculous lesions were found post-mortem in the lungs of 20.7 per cent. of them, of which 4.2 per cent. were incipient, 3.8 per cent. were rather extensive, and 12.7 per cent. were fibrous or healed.[1] That is, 8 per cent. of these people (38.6 per cent. of the tuberculous cases) had more or less active forms of tuberculosis. Therefore 61.4 per cent. of all the tuberculous cases in this series must have become quiescent and harmless by absolute cure or encystment and segregation. In another series reported by Koehler, about 26 per cent. of dissected bodies showed vestiges of tuberculosis, and in all these cases death from tuberculosis was positively excluded. These bodies were from among the poor and unfortunate.

It is an old record and an old doctrine that one-seventh of all people die of tuberculosis; that is over 14.25 per cent. of all deaths. These figures have been quoted so often and so long that they seem like a law of nature. But they are wrong for this day, whatever authority they may have had.

[1] Birch-Hirschfeld.

CHART II.

Showing the fluctuations in deaths from Consumption at different ages (in ratio of all deaths from the disease) as compared with the number of the living at the same ages. The heavy horizontal line indicates the proportion of the living; the zigzag line shows the deaths. (Compiled from the U. S. Census Reports of 1900.)



The mortality from all forms of tuberculosis now is not over 11 per cent. of all deaths, and that from the pulmonary form probably does not much, if at all, exceed 9 and 10½ per cent. in rural and urban populations respectively. Koehler puts the mortality from consumption in cities at 2.25 per 1000 people per annum (with a total mortality per 1000 of 21.8), or 10.3 per cent. of all deaths.

The United States census of 1900 shows 10.56 per cent. of all deaths reported in the registration sections of the country for the previous year to have been due to "consumption." The census of "general tuberculosis," being added, brought the proportion up to 10.68 per cent. These figures, it must be remembered, do not apply to the whole country, but to the "registration area,"— mostly towns and cities where the census officials believed that fairly accurate records could be procured.

The Public Health and Marine-Hospital Service of the United States has compiled the mortality statistics of 1435 cities, towns, and villages in this country for the year 1901, with this result: Total deaths, 365,216; from "tuberculosis," 41,938, or 11.4 per cent. of all deaths. This is more than double the number of deaths from enteric and scarlet fevers, measles, and diphtheria combined, these diseases having destroyed 20,787 people.

It is rather surprising that the figures from the

two sources quoted should vary so much. There is no doubt of the effort at accuracy of the persons engaged in the work of registration and compilation; their differing views as to classification of diseases and the diagnosis of the causes of death, together with the human tendency to error in figures and records, would make some disparity unavoidable. The records from the two sources, moreover, do not cover exactly the same communities; and it is to be regretted that we have no such adequate records of mortality in the rural districts as we have in the cities and towns. The farming communities certainly have a lower death-rate than the cities and towns.

In Germany in 1895 the mortality from consumption was 10.22 per cent. of the total mortality. The deaths from this disease numbered 215.3 in each 100,000 of the population. The death-rate per 1000 of population was 21.06.

The death-rate from tuberculosis is declining, especially in communities where repressive measures are in vogue. The United States census of 1890 showed, in the registration area, that the deaths from consumption and general tuberculosis combined were 12,146 for each 100,000 deaths from all causes, or 12.14 per cent. of all deaths; while the census of 1900 showed 10,688 to each 100,000 deaths, or 10.68 per cent. of the total mortality. In 1890

there were 245.4 deaths from tuberculosis in each 100,000 of the population; while in 1900 the number had fallen to 190.5. These figures show a reduction in the ratio of deaths from tuberculosis to total deaths of nearly 1½ per cent., and an actual lessening of deaths from the disease of over 22 per cent. of the higher figure, or more than one for each week in every community of 100,000 people.

This saving of life is probably to some extent more apparent than real; it probably does not represent 54.9 fewer cases of tuberculosis in the given community, but in part speaks for the better care of the cases, and so the postponement of the deaths of some of them. This argument applies to the decade just passed, which has witnessed a great improvement in the care of consumptives. It may not apply to future decades. But, allowing for this element and for possible errors in computation, there still can be no doubt that the mortality from tuberculosis is on the decrease in this country.

The mortality from consumption in Italy is decreasing. The annual deaths per 100,000 people during 1887 to 1889 inclusive were 107.53; during the three years 1895 to 1897 inclusive the rate had fallen to 102.63. This means a reduction from the higher figure of 4.5 per cent.

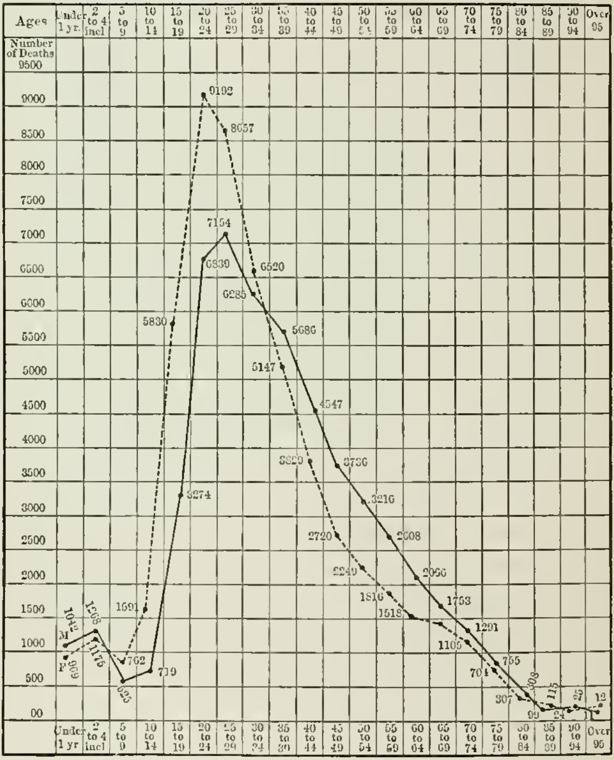
In Liverpool, during the decade ending with 1875, among 100,000 people there were 430 deaths from

this disease, or 4.3 per 1000; the next decade there were 309 deaths, or 3.09 per 1000; and in three recent years 256 deaths, or 2.56 per 1000. The deaths in nine cities of Europe for the decade ending 1890 were 3.82 per 1000 people; while for the same time in twenty-eight American cities it was 2.68. In Prussia, prior to 1889, the deaths from lung tuberculosis were annually 3.14 per 1000 people. In the following eight years it was 2.18 per 1000. In New York City the mortality from tuberculosis since 1886 has dropped 35 per cent. of its previous rate (Biggs). In Prussia, in 1880-86, the deaths from consumption were 311.2 per 100,000 people; in 1895 the rate had fallen to 232.6.

The mortality from consumption at different ages and of the two sexes, as revealed by the last census, makes a chapter of the greatest interest. The number of deaths, which is low during the first three half-decades of life, mounts rapidly during the next two or three, whence it falls steadily to the seventeenth (80th to 85th year). The mortality among females during this period is lower than that of males, except during the second to seventh half-decades inclusive (5th to 34th year), when it is considerably higher, especially during the years from 15 to 30. Chart III shows the facts in a graphic manner.

CHART III.

Relative deaths from Consumption in the two sexes, shown by half-decades of life, in the census "registration area," in which the deaths for the year, from all causes, numbered 1,039,094. *The solid line indicates males; the dotted line, females.* (*Compiled from the U. S. Census Reports of* 1900.)



In studying this chart it should be remembered

that the sexes are, in our population, not quite equal numerically, the census of 1900 having shown that there are 51.2 per cent. of males and 48.8 per cent. of females.

If 50 per cent. of all the people have tuberculosis some time, and 11 per cent. of all *people* die of the disease, that would make 22 per cent. of all tuberculous cases to die, and 78 per cent. to fail to die of the disease. Of these last, a part recover, to die of something else; and a part, failing to recover completely from the tuberculosis, are still carried off by intercurrent diseases. Even on the basis of the false assumption that the deaths from all forms of tuberculosis are 14 per cent. of all deaths, or 28 per cent. of all *cases* of tuberculosis, (*i. e.*, on the basis of a morbidity of the disease of 50 per cent.), then 72 per cent. of all the tuberculous patients fail to die directly of this disease. And this is a remarkable showing in recoveries from a disease that many of the people — most of them in certain quarters — have regarded as practically incurable.

It is impossible to say what proportion of the lung cases actually recover, but it is manifestly much larger than was formerly supposed. Probably few recover so completely as to have all the bacilli destroyed in the body by and in the healing process. Many recover by healing and encystment of the tuberculous area and products, including the bacilli,

to die of other diseases. What the proportion is cannot be known exactly; reports and estimates differ, and many of these are unreliable.

It is probably safe to say that the recoveries from known lung tuberculosis amount to 33 per cent. or over. If we are to generalize from the post-mortem and dissection records already quoted, the percentage would be much above this figure; counting all the hidden and unrecognized cases, the figure would probably reach 50 per cent.

Of the cases of tuberculosis of skin, bones, joints, glands, serous membranes, and encysted nodules in various parts of the body, a very large proportion recover. When the disease attacks the cerebral meninges, death is practically certain; yet Hektoen has reported one post-mortem study that showed a perfect recovery over small areas of a tuberculous meningitis. The disease continued to spread and so the patient succumbed; but the fact that healing has been shown to occur over any part of the affected tissues in this disease gives hope that occasionally a perfect recovery may take place.

The prognosis in individual cases depends on circumstances. These are — (*a*) hereditary influences, which means inborn resisting power to the disease; (*b*) the actual resisting power, as shown by the history of the case, in the ability (1) to limit the lesion by the process of fibrosis; (2) to avoid

pus infection and therefore fever — which means the ability to keep the disease from burrowing deeply and away from channels of exit for the products of the disease process; (3) to keep up body nutrition and avoid emaciation; (4) to maintain secretions and excretions; (5) in women, to continue menstruation; and (6) to avoid physical and physiologic calamities, such as overdoings, accidents, colds, fevers, complications, and pregnancies. If the showing in these several ways is good, so is the prognosis. If the power in these directions is low and the success poor, then the prognosis is bad. Most cases die that lack enough stamina of the kind that resists tuberculosis to recover under rest and the best hygiene. All complications and other diseases (as of heart, kidneys, digestive organs, and blood-making functions) add greatly to the gravity of any case. So do the burdens of the ordinary business of life.

There are certain physiologic peculiarities that stamp people as probably deficient in normal resisting power to tuberculosis. Among these may be named: a fastidious appetite; distaste for meat — especially for fat meat — and other articles of the common diet of mankind; inability to take stimulants, when properly diluted, without signs of gastric or cerebral disturbance from small doses.

The rate of progress of pulmonary tuberculosis

toward either recovery or the opposite varies with the cases. No two are alike. The disease is essentially a long one. A few cases of so-called "galloping consumption" run a rapid course and terminate in death in a few months; some of them seem to terminate in a few weeks, but nearly all such have had a longer duration than has been supposed. They have perhaps been progressing in a slow way for months before the nature of the disease was discovered; then this has spread rapidly and gone on to a fatal issue in a few weeks.

Patients are sometimes so little disturbed in health by the disease as to go on with their ordinary vocations for years with hardly a symptom beyond a trifling cough occasionally for a few days at a time. When these exacerbations occur, they suppose themselves to have taken slight colds. Even then the expectoration is sometimes slight; but there is nearly always some degree of shortness of breath that shows on running, especially running up stairs. This last may be so slight and may have come on so gradually as to escape the notice of the patient, unless his attention is fixed sharply upon it.

I have known men actively engaged in business and given to sports considerably athletic, who have carried tuberculosis in a single side for ten or fifteen years, as shown by repeated findings of bacilli, and who have passed in the community as well people

all the time. Their looks indicated normal, even superior vigor; they had only slight inconveniences, and these consisted of a trifling cough occasionally, and perhaps some moderate annoyance from chronically irritated joints. I have known a woman with tuberculosis of one lung, often free expectoration of bloody muco-pus, and occasionally fever, to maintain apparently unimpaired health for ten years, and in the mean time bear two children, each of which she nourished during a part of the nursing period. But, of course, in such cases physical examinations always reveal slowly progressive fibrosis of the affected lung, and some contraction of it as shown by circumference measure.

During the exacerbations, too — the periods of the "colds"— there is often daily elevation of temperature to the extent of a quarter to half a degree; but in the intervals, which often extend to many weeks, there is normal temperature at all hours of the day. In such cases the tuberculosis is mostly confined to the bronchi and peribronchial tissues, where the irritation of the disease always provokes the formation of fibroid tissue to cause thickening and contraction. There is no tendency to the formation of suppurative foci outside the bronchi, the products of which would be unable to find exit through the tubes, but would be absorbed into the blood and produce fever.

It is a general truth that of those forms of pulmonary tuberculosis that do not produce fever, the prognosis is relatively good. Persistent high fever, with or without much pus discharge externally, means a bad prognosis. The prognosis is bad, too, where there is little fever, cough, or expectoration, but where there is progressive emaciation and dyspnea, with no dulness on percussion or bronchial breathing and with diminishing true respiratory murmur. Such cases are of the dissolving type, where the lung-substance slowly disappears by disseminated ulceration of the vesicular tissue. The cases that promise most for resistance are those where fibrosis occurs in mass around the tuberculous focus, and this always shows itself by bronchial breathing and some dulness on percussion. Excessive general fibrosis of both lungs, however, makes the prognosis ultimately bad, since it is almost sure to increase slowly until it chokes the blood-supply to the parts concerned in respiration, causing thereby dissolution of air-vesicle walls, and so finally wearing out the patient.

CHAPTER X

THE PROPHYLAXIS OF TUBERCULOSIS

Prophylaxis of tuberculosis is next in importance to the treatment of it. There is hardly any ground for hope that tuberculosis can ever be wholly extirpated as a disease of mankind. But there is much that can be done to reduce the number of cases; and danger to life from the disease will be lessened somewhat by measures that tend to decrease the cases. If it is true, as it probably is, that most of the bacilli with which human beings are infected come from the bodies of people, then measures to lessen the number of them at large must be potent in reducing the danger of infection. This is the direction in which we can do most good, and in this way we should make constant and strenuous war against the disease.

To reduce the number of bacilli in the air is a cardinal necessity, and to reduce them in the food and drink is important. Much can be done by patience and insistence in the destruction of sputum. The sputum can be easily destroyed by heat or chemicals (carbolic or bichloride solutions), and most of it can be caught in spit-receptacles, which should always be within reach of the patient's hand, so

that it may be destroyed. These are to some degree attainable measures. We can insist that tuberculous patients shall care for their expectoration in some way to prevent it from becoming a part of the dust of the air. It will require constant watchfulness, often some severity, and a good deal of missionary work to create a public sentiment that will demand it, but it can be done — and without actual hardship to the sick.

The body- and bed-clothing used by patients ought to be disinfected from time to time by the heat of boiling water or of an oven or by chemicals — as formaldehyd gas or wetting with 1 : 500 corrosive sublimate solution. Keeping clothes in chests or closets strong with formalin is a good way, or exposure to many hours of intense sunshine. This is a precaution that is rarely taken, but ought to be whenever a patient has a cough of an intense character and rather fluid sputum, for then small particles of it are sure to be ejected upon the clothing. Patients should be discouraged from wearing beards, particularly mustaches, and from the use of utensils in common with other people. This last is a means of distributing the bacilli occasionally, but I believe not often. Nor do I think that the kissing of consumptives is a frequent means of transmitting the disease. But there is no doubt that projectile cough is a common method of disseminating the bacilli.

Those patients who have what is known as a hard, dry cough often project minute particles of bacilli containing phlegm three of four feet into the air, without their knowledge or suspicion. These particles, when dry, are more or less ground into dust by the movements of the garments, to be perhaps inhaled by others. Patients may be urged to hold a cloth before their faces while coughing in that manner, but most of them will forget, become heedless, or disbelieve in the need of it, or even refuse to try the measure.

Most people will not, except in sanatoria, have their body-clothing disinfected from time to time, so that dried sputum contaminating it shall be destroyed. The average person in private life will not do this, even if you implore him to. Nor is the measure perfectly effective to protect others from the bacilli lodging on the clothing. In order to be a perfect safeguard, the clothing would need to be disinfected daily — and probably that is a degree of scrupulosity that we can hardly expect patients and care-takers to attain. The melancholy rule in vogue is, both in private practice and in hospitals, never to disinfect the outer clothing at all; probably not two per cent. of the patients ever have this service done for them, yet it ought to be done for every one of them. It is most needful for the patients who are housed, and for all patients

in cloudy weather. Those who are much in the sunshine have by that influence quite an effective disinfection of all the outer garments. If clothing can receive no other disinfecting agency it may usually without much trouble be exposed to the bright sunshine, and not less than this should be done.

Something can be done toward the destruction of sputum by legal steps against spitting in public places. But ordinances against spitting on sidewalks are not so useful as has been supposed. If women would always wear short dresses, never gowns that sweep the ground, and if we could avoid treading upon the sputum, I am sure that, aside from esthetic reasons, it would be better to allow spitting on the sidewalks rather than in the streets, for on the sidewalks the sputum receives more direct sunshine which may destroy the bacilli, while in the streets it gets rolled in dust that impedes the sun's rays, and so the bacilli persist longer and become more readily diffused through the air. Of course, every legal restriction should be sought to prevent people from spitting in street and railway cars and in all public conveyances, and in such places as public halls and lobbies. But ordinances will not execute themselves, and if they are ever to do the public any large amount of good, some one must assume the unpleasant duty of prosecuting offenders. This is a task that everybody shirks.

Some special instruction should be early given to every patient as to the care of his sputum. If he expectorates infrequently, and can to some extent control the function, he may always find a cuspidore with water or other safe place of deposit for the sputum. But if the cough is frequent and the discharge uncontrollable, he should always have some spit-receptacle upon his person or within his reach, and should use it with absolute constancy for every particle of tangible sputum. The receptacle must be destroyed, or emptied, cleansed, and disinfected, every day or several times a day, with the certainty and precision of clockwork. In no case should the expectoration be swallowed — nor should a handkerchief be used for a receptacle; this breeds carelessness and a spread of the bacilli, for usually the patients do not promptly and fully disinfect their handkerchiefs thus polluted.

There are numerous hand and pocket spit-cups on the market for tuberculous patients, some of them simple and ingenious, others ingenious and complicated. Patients differ in the ease and skill with which they use these utensils. The test is, of course, effectiveness. No cup should be used that breeds carelessness or that fails to catch and hold completely and neatly all the tangible sputum.

One of the best devices of all is an ordinary newspaper folded many times, and the folds cut out on

all sides but one, so as to make a rude book, between the leaves of which the patient spits. He can safely carry it in his pocket, to be burned at the proper time, and can have a new one several times a day if necessary.

Another proper scheme is to have a pocketful of pieces of soft cloth or paper to be used for the sputum and to be stuffed into a paper-bag as soon as contaminated, the bag and its contents to be duly burned. But the habit of putting these polluted cloths or papers into a pocket of the clothes, or the saving of the bag for continuous use — even a bag of oil silk — is unsafe or actually vicious and ought not to be countenanced.

Rooms in which people die of tuberculosis, and where it is not certain that the greatest care has been used to keep them from being contaminated, should be disinfected with sulphur or formalin. Such contaminated rooms doubtless often spread the disease. And I believe that it is best to have local health officers required as a matter of routine duty, when a case is reported of death from tuberculosis, to investigate the premises, and if they find reason to believe there has been carelessness in the care of the patient, to insist upon disinfecting the rooms. Such a procedure, discreetly carried out, would probably arouse very little anatgonism on the part of the public, while it would do a great deal of good.

The best way to disinfect a room is probably by the very thorough use of formaldehyd gas, discharged by evaporating formalin over a fire or lamp, a pint being used to a room of 100 square feet of floor space; or by some other apparatus that will discharge the pure gas into the room. The formalin is often evaporated from hanging sheets, but this is less effective. The rooms should be closed and sealed during the process, and not be opened for twenty-four hours. Rooms may be purified nearly or quite as well by washing floors, woodwork, walls, and ceilings with a rather strong solution of corrosive sublimate, say 1 : 1000 or even 1 : 500. The surfaces do not need to be rubbed with the solution, but simply wetted, and they may be wiped dry in five minutes, after which the rooms are ready for use again.

Another prophylactic measure that has been attempted in a few cities, and one that would do much good if it could be carried out, is a requirement that physicians shall report to the Health Department all cases of tuberculosis, exactly as they do cases of scarlet fever, diphtheria, small-pox, and other contagious diseases. Tuberculosis is in a way contagious; scarlet fever is, but differently, and many physicians claim that the two diseases should be dealt with in the same way. If health officers knew where all the cases of tuberculosis are, they might

exercise some wholesome repressive influence over the distribution of the disease. But they cannot know of all the cases, nor half of them, and the people are probably not sufficiently advanced, or used to official supervision at present, to submit to such a rule unless very discreetly administered. Some few cities have adopted the regulation, but it has so far never been effective. Both public and profession disregard it to a large degree. Many physicians fail to report their cases frankly; they forget, perhaps wittingly, to make a diagnosis, or call their tuberculous cases by some other name; and the people are ready to connive at such a course.

This is hardly to be wondered at. A disease that at some time in their lives attacks at least half of all the people, and makes a large percentage of these its victims; that often permits them to go about and appear to have only a simple cold or to be merely a little depressed or debilitated, and that has a range of duration from a few weeks to forty years, cannot be regulated by law as scarlet fever, small-pox, and diphtheria are. These diseases come on and terminate rapidly, and much is done to limit the spread of them by current methods of prompt legal identification, so that the people readily acquiesce; but tuberculosis offers in many particulars a different problem and requires different dealing.

Probably the time will come when in many com-

munities most of the cases of tuberculosis will be reported; but a large measure of delicate and considerate discretion will need to be exercised by health officers in order to make it possible. If such a measure could be thoroughly carried out, it might be of great assistance to the public in preventing the spread of the disease through the dissemination of the bacilli. This is almost the sole way in which the disease can be limited, and this benefit must for a long time to come be expected — and needs be sought — mainly through the efforts of physicians and the enlightened sense of the general public rather than by attempted official regulation.

There is another direction in which we can do something toward preventing the spread of tuberculosis. That is by discouraging the use of carpets and the sweeping of rugs in houses. Rugs should never be swept as they lie on the floor, and carpets are a hygienic abomination; they fill the air with dust and pollution of many sorts, and undoubtedly spread tuberculosis. A housemaid will cover and protect her hair while sweeping them, but will breathe the dust and filth into her lungs.

We can reduce the tubercle bacilli in food. The only foods likely to cause the disease in people are meat and milk. If meat is cooked it cannot transmit the disease, for a temperature of 180° F. destroys the bacilli. We naturally object on esthetic grounds

to eating the meat of tuberculous animals, but if it is well cooked, no harm can result to the health of consumers. Many States require by law the destruction of tuberculous cattle, as these are the only animals that can be to any considerable degree, if indeed they are, a menace to mankind in this direction. Such laws are both good and bad: good because seriously sick animals should be slaughtered; bad if the execution of the laws is so literal and sweeping as to sacrifice a great amount of property that does no harm to any one. This latter has been done in certain States, causing unnecessary burdens to the taxpayers who have had to pay for the slaughtered animals. As a result, some of the laws have been repealed.

Professor Russell of the University of Wisconsin has demonstrated that there is no need of destroying all tuberculous cattle. An animal slightly sick, and put under hygienic conditions, will ofter recover; its lung lesions will become encysted, as those of man often are, and it will be well except for the scars remaining after the disease. And it is a question whether we should be squeamish about a food animal that looks well, but in which a few bacilli are found (in non-food parts chiefly), when the meat is cooked and eaten by people one-half of whom have bacilli somewhere in their own bodies. Calves of tuberculous cows, if prevented from taking their

mother's milk until it has been pasteurised, may subsist upon it without acquiring the disease. It is better and easier to take care of cattle than of people, and there is more hope of recovery for them. In the next few years the laws directed against tuberculous cattle in this country will probably be modified so that animals that are manifestly sick will be destroyed at public expense, and the healthy looking ones, even if they do react slightly to tuberculin, may be kept, if people will house and care for them.

The laws ought to require the State to exercise some supervision over herds that are even slightly infected with tuberculosis, in order to prevent the spread of the disease. But it is more important to supervise the dairies, and to prevent the distribution of milk that is out of condition or is below standard, than to supervise the meat that goes into private houses. Here is a direction in which physicians can do a useful service. Dairies selling milk to the public should be inspected frequently, and all sick cows eliminated in some way. If they react to tuberculin in the slightest degree, their milk should never be sold to the public. But it may be pasteurized and used as food for pigs or calves without harm to anybody. The danger of tuberculous cows' milk carrying the disease to the intestinal canal of children is shown by recent studies by Koch to be

greatly overrated. By his estimate, based on great numbers of careful post-mortems, the children who have primary tuberculosis of the intestines are not one per cent. of the whole number dying of tuberculosis. This goes far to prove that children rarely take the disease from infected milk. Nevertheless, the selling of tuberculous milk should be made a crime by law.

How may an individual avoid acquiring tuberculosis? Direct infection needs only to be mentioned. One should avoid getting tuberculous sputum or other bacilli carriers on the hands or on excoriated surfaces of the body, and avoid going into great accumulations of bacilli. One probably cannot escape the bacilli altogether in towns and cities anywhere in the world, but he may avoid going where they are very numerous and where there is evidence that they are thick in the dust of the air. As already said, it is less a question of who gets bacilli into his system than of who fails to resist them. Almost anyone can probably resist a few on his mucous surfaces, but scarcely anyone who takes in a swarm of them.

There is no need of fearing the tuberculous patient if he is well cared for — the thoughtful and considerate patient who knows he is tuberculous. It is, in my judgment, a great wrong both to individuals and to the community to keep such patients

in ignorance of their true condition. With very few exceptions, patients with tuberculosis should know the fact. It terrifies them less to know it than it does their friends; and if they know how they may constantly put their neighbors in peril, they will usually be careful. In many health resorts people refuse to take such patients to board, even if they are known to be scrupulous in the management of their sputum and to follow all the prescribed regimen. This fear is really groundless if the patients are careful; but to be careful is to destroy all sputum and even to disinfect regularly, by sunlight or otherwise, all outer clothing, so as to prevent the minute particles of sputum ejected in coughing, and lodging on the clothes, from contaminating the air. Nurses of consumptives, if careful of their patients and careful of themselves, rarely take the disease unless they become reduced in health.[1]

To avoid tuberculosis one should keep himself well, even vigorous, and do those things that tend to keep his body in a normal condition. The fault of most of us is that we do not keep in a normal condition; we work too much, have bad digestion,

[1] The experience of the Chicago Hospital for Consumptives under Dr. Wood is instructive. So great was the scrupulosity in the care of the sputum, that, after a continuous occupancy of the building by an average of 100 patients for over two years, it was impossible to demonstrate bacilli in the dust gathered from the wards.

pay too little attention to ventilation, are housed too much — are too little in the great out-of-doors. Then we are, many of us, foolish enough to believe that if we exercise greatly and become athletes we shall escape the disease. It is almost as much a risk to carry the system above a normal condition of muscular vigor as it is to allow it to fall below. Excesses of all sorts predispose to tuberculosis.

The kind of lives that many young people lead predisposes to the disease. I mean lives of spontaneity. If they enjoy work, they overdo it and go without sleep; they neglect disturbances of digestion, neglect constipation, and they stimulate — because they like stimulants or because they are invited to take them. As a result, they live much of the time below their proper physiologic standard. Considering these circumstances, it is no wonder that tuberculosis is as prevalent as it is among the young.

Wherever careful and systematic measures have been consistently carried out toward prophylaxis, they have succeeded to a most encouraging degree. The records of many cities show this, and they will hereafter show it more. But these benefits have come mainly through the lessening of the bacilli in the air, not so much from any improvement in the habits of the public. People who are careful of their health and see to it that they keep steadily

in good vigor are more likely to avoid the disease; and the people who need to learn this lesson belong to all ages of the activity of human life. The cardinal doctrines, to be emphasized at all times, are: Keep well and normally strong; always breathe the best and cleanest air; and avoid the bacilli of tuberculosis — not by making pariahs of the sick, but by a never-ending wise campaign for the destruction of these microbes.

It is easy to say what precautions may limit the spread of tuberculosis. They all have for their chief object the limitation of the bacilli, mostly in the air; but the difficulty comes in trying to have them enforced. And there are many patients, mostly among the poor and ignorant, who never will, in their own homes if they have such, or wandering from place to place, carry out any measures of caution. There is only one way to prevent them from daily spreading the contagion, and that is to segregate them from the rest of the community in sanatoria at public expense. That this will some time be done to a very large extent I have no doubt whatever. Several States are already moving in this direction, and others will follow.[1] Nor will it in the end be any special burden to the State, for this precautionary step, by lessening the disease

[1] Massachusetts already has maintained one such sanatorium for some time, to the great satisfaction of both profession and public.

in the community, is sure to prevent other losses that are vastly greater in a pecuniary way than the cost of the sanatoria.

In a sanatorium it is possible to control irresponsible and careless people and make them mindful of their habits and the harm they are liable to bring to others. It is not possible to do these things anywhere else.

CHAPTER XI

TREATMENT OF TUBERCULOSIS. GENERAL PRINCIPLES

I WISH to speak first of some general considerations of the management of tuberculosis, and afterward to deal in more detail with the several phases of the subject. The most natural thing to seek first is some means to destroy the bacilli of tuberculosis in the diseased body, without serious injury to the body. Many investigators have worked on this problem and numerous experiments have been made, but all to little effective purpose. No germicide that fills these conditions has been found. Possibly some of the so-called antitoxic animal serums, some modified products of tuberculin, and drugs that increase the leukocytes of the blood, like nucleinic acid and nucleins, may repress the growth and spread of bacilli a little; but if they produce this effect, it is not known whether they do it directly or indirectly; and proof of any great power on their part is wanting.

The chief factor in the recovery of victims of non-surgical tuberculosis is the power of their own physiologic resistance. Their prospects of recovery are enhanced by an increase of this power and are always lessened by the slightest reduction of it,

and no measure of treatment that lowers or neglects this power is entitled to serious consideration. All through the long course of sickness the truth is daily verified, that any depreciation in the general vigor and resisting power is followed by an increase in the evidence of the disease, while any manifest increase of physiologic force is straightway followed by a decrease in the symptoms. To adopt any treatment that neglects or lowers the physiologic resisting power, in the hope of producing some mysterious destruction of the disease itself, or its bacilli, is constructive suicide, if not constructive homicide. So far as we know, the bacilli within the human body may be killed or imprisoned by the forces of the body, not by drugs or other things put into it. And how to increase that power is the paramount purpose of treatment.

One of the great obstacles to the successful treatment of medical tuberculosis is the widespread notion, both in and out of the profession, that the treatment may be short and that satisfactory results may be attained quickly. The truth is that the disease is long and chronic, and that treatment must be long and sustained, and of such a character that it may endure and be borne for a long time.

Unfortunately, most of our treatment of tuberculous patients heretofore has been haphazard, or based on the theory that there are only a few things that

we can do for them. One of these is to send them to a climate for consumptives, and another is to keep them at home and prescribe drugs, chiefly such as cod-liver oil and guaiacol or creasote. With these patients we should least of all think that a particular drug is of any great value against the disease, and that we can do our duty by prescribing it. This is the smallest part of the right management.

Regarding every patient who comes to us, we should ask the question at the beginning whether the probabilities are that, under any management whatever, there is hope of recovery. Of course, as to some cases, when they first come, it is a foregone conclusion that death must be certain and rather speedy. Take a patient, for instance, in the years of adolescence, with a bad family history, who has a large lung infiltration that has come on rapidly with high fever, and therefore extreme mixed infection. We know that for such a patient there is no possible recovery. But many have small deposits developing slowly, and strong physiologic powers; they have little fever and good digestion, and thus a good prospect of recovery.

If in any case the prospect is even fair, we should outline a campaign like one of war, for it is such a campaign; and the fact that it is a long and not a short one should be strongly impressed upon the patient. His course should be mapped out in minute

detail, and be put on paper if necessary. As it may often go to the length of making him uncomfortable, the fact should be impressed upon him that its purpose is to save his life. He should know the character of his disease, and its dangers. We may find it necessary to restrict his pleasures, to segregate him from his friends if they are harmful to him or he to them, and to prescribe many things that are unpleasant. We may fairly try to enlist him in a long and perhaps arduous and self-denying campaign if there is a chance of saving his life, and he should know the full meaning of this last consideration, and feel it if he can.

If there is little or no chance of improvement, we should pursue a different course — one that more concerns the present comfort, even pleasures, of the patient; and so we can never have a routine treatment for this disease. We may, if it seems best, refrain from telling this patient the full nature of his disease and his prospects, and should never say that his case is hopeless; and we ought to manage him so that his pleasures will not be much interfered with, and will yet be prevented from harming him much. Many of these patients may be kept comfortable by our ministrations, and death may come to them so slowly and unconsciously that they will never lose hope. They may plan for their temporal affairs up to within a short time before or

even to the hour of death. To these we do as great a service — to their hearts and minds and to their friends — as we do to those who recover, because we make their sickness as happy as possible, and almost completely painless.

For those who have a fair chance of recovery we should plan our treatment logically and consistently; and there are a few cardinal facts that must always be considered in every case of this sort. The patient should, as a rule, know that he has tuberculosis, and know what the treatment means. He should know his own danger, and what danger he brings to others.

The first lesson for him to learn is that it is his chief business in life to get well if he can, and that for the present he has no other vital occupation. Only the necessities of existence are an exception. You will find among such patients business men and young men planning to engage in new kinds of business, or to go on with their old ones in their wonted intensity, when there is really no need for them to work, and they are able to devote their lives to getting well. And they are sometimes eager to launch out into all sorts of social diversions and imagined duties. Every one of these schemes must be demolished if possible. You must charge the patient that such devices are worse than useless; that he must devote himself to his sole duty of recovery if he hopes to succeed.

The treatment ought to be so planned as to restore the already lowered power of resistance, and thus lessen the lack of balance between the vital powers of the patient and the load they are required to bear. The powers that are below par must be raised; none will need to be brought down. Rest, exercise, and tonics may carry the patient up to his physiologic par; this should never be exceeded, and so no athletic exercises are to be indulged in beyond the evident requirements of the normal standard. The exercises that can be used with propriety are all gentle, as some non-tiring outdoor occupation like horseback riding, driving, and walking, and these never to the extent of increasing the musculature above normal. The general activities of life must be reduced. Many a patient can recover and live long if he will be content with a more moderate speed, when he would kill himself in a year or two if he insisted on his habitual gait.

The forces that have reduced the average patient must be studied and dealt with. The first is too much work, too much strain of some kind. The natural remedy for that is rest, and for the fever cases complete and absolute rest. Next is lack of sufficient perfect and clean air to breathe. This is the common affliction of nearly all the people. The remedy for this is obvious, but it is one of the most difficult remedies to induce people to take. The fever pa-

tient must never be permitted to exercise under any circumstances if we can prevent it, and I wish to say this with all the force possible.

For those without fever there must be a change in exercise and occupation. The effect upon the human body of a change in activities, work, and scene is remarkable. It rests the tired brain powers and the tired muscles, and puts the strain on muscles that have been little used and on mental powers and forces that have been resting for long. That is to say, it shifts the load. If you carry a heavy load on one shoulder until it is tired, and can then shift it to the other shoulder, it rests you and gives a great sense of relief; it not only rests but it strengthens you, and enables you to conserve power. The same is true of mental and nervous experiences.

We are creatures of custom as to work and rest. We rest usually one day in seven, and work perhaps eight to twelve hours out of the twenty-four; business and professional men often work fifteen hours. We eat three times a day and sleep about seven or eight hours, and are in bed a little over eight hours. These are habits grown out of experience, and fit the needs of the well. We must start out with the postulate that all this ought to be changed for the average tuberculous patient. From being recumbent eight hours in the twenty-four, he must recline twelve or fifteen hours; for bad cases,

the longer the rest and the more complete it is, the better. He must, if poorly nourished, change his eating habits to four or six food doses a day, with corresponding changes in his dietary. He must understand that he is not like a well person, and must have some rules of life that nullify certain of the customs of society.

Ordinary house-air, and especially bed-room air, invites tuberculosis, and fosters it when present. We all breathe too little good air. The house-air usually contains more or less dust and bad gases, is lacking in oxygen, and contains too much carbon dioxid. Patients should breathe air as free from dust as possible, and constantly outdoor air, or as near that as can be had; and the night-air is the best of all, since it is the cleanest. Nearly all the benefit that comes of going to a resort for consumptives is due to the fact that the patients are placed where they breathe better and purer air. A primary purpose is to be much out of doors, but almost the sole benefit from that comes of the purity of the air breathed. Nor should the inspired oxygen be reduced by breathing through reducers—little mouth-tubes that impede the outflow or inflow of air, and distend the air-vesicles of the lungs. Moreover, such devices probably injure the lungs, as also do repeated profound unimpeded inspirations, since they both tend to put the diseased lung-tissue on the stretch, which

is almost sure to do harm. It is substantially impossible that a severe physical strain of tuberculous tissue can ever do good.

Many of the patients have poor nutrition, take too little food, and often of the wrong kinds, take it in the wrong way, and have bad digestion almost constantly. A study ought to be made of each case, with a view to improving these conditions. How and when shall a patient take food, that the best digestion may be attained and the best use be made of such digestive power as he has and can have? The fault usually is that the tasks put upon the digestive organs are too large and too few. The patient may need to have food six times a day instead of three, and the portions to be reduced in size. The articles of food, the methods of preparation, and the ways of eating may be wrong, and need to be changed in order to avoid discomfort and other symptoms of poor function. The dose of food should be reduced to the point where it will, if possible, be well digested, and the eating-times be as frequent as possible and not interfere with digestion. That is, the best use should be made of the power of the organs that make blood; and, weakened as they are by the tuberculosis, that power is best expended on small quantities of food taken frequently.

The patient may have a pain in the stomach or

bowels, and, if the physician is not careful, he will find himself prescribing bismuth or some other quieting drug when the better remedy might be a change in the food or the dose of it, in the method of cooking or the insalivation of it, or the use, perhaps, of a little of some of the pharmaceutical aids to digestion. Discomfort in the bowels may be due to indigestion or to lack of drainage, and the drainage from the colon may be deficient, notwithstanding a loose stool each day. For diarrhea astringents are likely to be prescribed when perhaps all that is needed is a careful attention to the regimen. If careless, one may prescribe some physic for constipation, to be followed by worse constipation, when an enema or an intestinal tonic might serve the purpose and be followed by no ill-effects.

It is curious how the moral and mental conditions of life, the daily worries, disturb these cases. Two sets of people may work side by side, and one set receive a few cents more wages a day than the others, living perhaps on the same kinds of food, and under conditions similar in every other respect. But the poorer-paid set will have more sickness than the others, and have less resisting power when they are sick. So the mental state of the patient is always a leading factor in his prospects. Often a change of climate relieves the moral monotony; but in advising a change, if a physician is not careful,

he will toss his patient from the frying-pan into the fire. One may advise him to go off to a good climate for consumption, and, in so doing, take him away from his friends, their care and sympathy, and, no provision being made to take the place of these, his disease may not only be unimproved, but may get worse because he is homesick and unhappy.

The free stimulation in which your patient has perhaps indulged, and excesses of all kinds that have lowered his vitality, must be corrected. The patient is to have no excess in his life whatever; his life must be serious and tranquil, and may be happy. If a young man, he ought to live the life of a man of forty-five. The trouble with such advice to young people is that they are mostly incapable of the enjoyment of the life of a person of forty-five, because they lack the mental perspective and capacity for the higher pleasures. Few people will ever have any such mental joys in the time before as they will after that age. Youth has no perspective; it cannot look back and see the relation of things, and so be able to weigh them; and it frets and fumes about a lot of questions that it tries hard to settle. At forty-five the ripening of the mind is so much advanced, and mental pleasures are so much greater, that one who has reached that age in serenity is to be congratulated. He has the power to minify the carking effects of his sickness.

We are apt to declare that a person in health does not need stimulation, yet we all indulge in it more or less. We drink coffee and tea and use tobacco (there are some who contend that tobacco is not a stimulant), and we take various forms of alcohol and numerous condiments. But the records of armies and life companies show that normally healthy people can live longer and endure more without than with alcoholic stimulants. Probably this is true of all stimulants. If a person with tuberculosis has been in the habit of taking stimulants excessively, he should stop the excess anyway, if not the habit entirely. But such a patient who has never had the habit will often find alcoholic stimulants beneficial, if taken regularly as a tonic and in moderation. And if taken, a stimulant should be used with the same regularity as any other drug. There are some who cannot take alcoholic tonics at all; who get light-headed and red-faced, and are generally uncomfortable on taking the smallest quantity. These persons have, I believe, less resisting power to the disease than those who can take alcoholics with comfort and benefit.

There are numerous drugs that, taken internally, do various degrees of good; they aid the functions of the body, and so the powers of life, and they are mainly tonics. But some are corrective of faults of secretion, of digestion, and of depuration; some are

really foods. Average the cases, and it is a truth that in the past too much medicine has been given to patients with tuberculosis. The doses have often been too large, and the drugs have been given at random and without due consideration of symptoms. Great harm has resulted from the excess of the drugs, but far greater harm has come from the fact that reliance upon them has obscured the potent resources of hygiene that must always be the mainstay in the treatment of this disease.

There are measures acting locally on the diseased region that are in certain cases useful. One of these is immobilization of the lung by inflation of the pleural cavity with nitrogen or air, according to the method of Murphy. This is applicable in incipient one-sided cases. Another is the use of adhesive straps or other apparatus for the same purpose, and applicable to such cases in all stages of the disease. Another method is partial immobilization of the diseased lung by muscular control on the part of the patient himself. The lymph treatments are of some value, but only a little. Like the use of drugs, these measures are only secondary.

The climate treatment is, when properly used, the best of all the measures of benefit; but it should never be prescribed unless one is sure that it can be taken in the right way and be attended by all the aids that are otherwise available. Many times it is

worse than useless. The patient in any climate must be properly fed, housed, clothed, and warmed. It is just as important that he should have contentment and mental peace. I would rather have a patient kept in the outskirts of an Eastern city (or even in the heart of the city), under good hygienic management, sleeping in the best air obtainable winter and summer, and with his friends and comforts about him, than to send him to some better climate to shift for himself and be lonesome and homesick. If a patient can have all the conditions for happiness in the new country, then the right change of climate is a thing of paramount consequence; but to send him away to a strange region to shift for himself, and perhaps to do a hundred foolish things, is worse than useless. He may be instructed in detail how to take care of himself, and he may strive to follow the directions implicitly; but even if he does so for thirty days, he is almost sure on the thirty-first to do something that will pull down all the good he has done himself. Explicit directions of caution can be observed to the letter in a sanatorium, and if the patient is subject to daily watchfulness or is under the care of a competent nurse; but almost never when he is left to care for himself, and subject to all the conflicting and manifold advice of officious neighbors.

It is never safe to regard a case of tuberculosis

as permanently cured simply because the symptoms have disappeared. A long time must elapse before healed ulcers and closed-up cavities can be trusted as being beyond the danger of easily breaking open again. Scar-tissue must become hard and quiescent, and a year at least is required for this to occur — and that after all evidence of progressive disease in the tuberculous focus is gone. Nor is it always safe to rely on the appearance of recovery from this disease in the lungs, for active disease or pus drain from some other part of the body may cause a temporary abatement of the lung symptoms without the slightest progress toward actual recovery of the lung. Cough and expectoration may subside and rales disappear by the influence of a diarrhea or a suppurating sinus in some other part of the body, or a chronic non-tuberculous inflammation in a distant organ. Even the condition of pregnancy may cause a nearly complete cessation of symptoms until parturition is over. Then the disease generally flares up and makes rapid progress, usually to a fatal termination.

These general principles will be elaborated and enlarged upon in the chapters to follow.

CHAPTER XII

TREATMENT, HYGIENIC

The hygienic treatment of tuberculosis is the most important of all. This means the putting of the patient under such health conditions as to preserve and conserve to the utmost his forces of life and his resisting power to the disease. In carrying this out it is important that we should give definite and detailed rules as to what the patient is to do, how he is to care for himself, the food and drink he is to take and the times for taking, the hours to be spent in bed, the hours out of doors, and the things to do and to omit, and all matters of ventilation, clothing, excretions, and the care of sputum. Left to himself he will not follow good hygienic lines much, and relying on verbal directions he may forget; hence written and minute directions are often needed. They may now and then save a patient's life.

At successive visits it is vastly more important that we should inquire if the patient has carried out his hygienic rules than if he has taken his medicine. When variations in the symptoms occur that are unpleasant or ominous, we can often help him better by changing some detail of his management than

by changing his drug treatment. Furthermore, if we lay special stress on the importance of these rules, the patient will probably follow them; otherwise he is likely to forget and to become careless, and do or omit things that may put him back a month in his recovery, or directly hasten his death. In sanatoria great account is taken of such details, and patients come to think of them as more vital than anything else — more even than their own physiologic forces. We can as truly impress these ideas on patients living in their own homes if we are in earnest and insistent, and if we are patient and persistent.

In carrying out this treatment, tranquillity on the part of the patient and a great deal of rest are among the most important measures. A patient with fever must be kept horizontal for at least three-fourths of each twenty-four hours. It is often best to keep him in bed for some weeks continuously; and he must take his vertical life in two to four periods each day, so that he is never up for long at a time. Exercise, even the little involved in the erect posture for an hour at a time, increases the temperature of a fever patient. Given infection enough to produce even slight fever, and a small amount of exercise is capable of increasing it.

The patient must be guarded from distress of mind as well as body. If things worry him, it is

just as bad as if he exercised physically; it will send his temperature up. To give him the best hope he must also be free from nostalgia, for that is as bad as exercise. He must not be worried, but cheerful; he must be a philosopher about his own case, and take enforced idleness gracefully; and this last is probably the hardest lesson that he will have to learn.

For a tuberculous patient with no fever, a moderate amount of exercise is proper; but never for the purpose of developing muscle, as that term is usually understood; never because it is a duty; solely because he feels like it. You get up in the morning and stretch your muscles because it makes you feel good to do so; you take a walk because every step is a joy. Your non-febrile tuberculous patient may exercise on that basis with propriety, but should never carry it to the extent of the slightest fatigue that is not promptly recovered from by brief rest.

Many a time the patient will not be able to sleep; he will fret and fume because he cannot, which always increases the wakefulness. For this symptom drugs are to be avoided if possible, unless the sleep is broken by dry and unproductive cough. A potent remedy for nervous insomnia is for the patient to resolve that he does not wish to sleep and will stay awake, and in nine cases out of ten he will drop into slumber in a few minutes. To sleep well one must be

tranquil and untroubled; and if he sincerely resolves that he prefers not to sleep, but to lie awake and perhaps read an unexciting book, that mental attitude makes him tranquil and invites drowsiness. A hot-water bottle or a hot foot-bath for cold feet will often induce sleep; as will an enema for a loaded colon, or a drink of sodium bicarbonate solution for a sour stomach, or of warm milk for an empty one.

The thing that a physician will find most difficult to bring about with such patients is the outdoor life. That is nearly if not quite as important as the rest of body and mind, and it is the chief factor of benefit in nearly all the climatic influences that come to these patients — the outdoor life, the breathing of fresh, pure air, and the getting of some sunshine. The sunshine is extremely valuable, but less so than the fresh air.

There may be elements in the outdoor air that are valuable besides the due amount of oxygen and the freedom from contamination, but we assume that these are its chief advantages. We had thought for a century that we knew all that the atmosphere was composed of, and all the advantages of a pure air and all the disadvantages of an impure one. It was left to the last decade to discover in the air the new substance argon, of whose influence on animal physiology we are completely ignorant. Other elements may still be discovered that possibly will fur-

ther explain the great influence of slight changes of the atmosphere on the human body. Patients should religiously keep away from indoor crowds, whether in theater, hall, or church; for there they always breathe the worst possible atmosphere.

There is no doubt of the great value of outdoor life to these patients, and it must be mostly due to the better air they breathe. It has been found practically impossible to ensure in a house or a hospital ward, with any attainable provision, a constant atmosphere that does not contain at least twice as much of those contaminations harmful to man as are found in the outer air. This is a sufficient explanation of the great benefit that patients experience from living out of doors.

It requires a great deal of preaching and persistency on the part of the doctor to keep some of the patients out of doors. They will hesitate, fear they will take cold, declare it will kill them; and generally fail to appreciate the vast importance of this measure.

Even when one has consented to try to do it, the art of staying out of doors is one that has to be learned. Especially is this true when the weather is cool or cold. A man told to be out of doors say for ten hours a day will sit on a porch if it is warm and agreeable; but if it is cool he will think he must walk constantly or ride horseback to avoid

feeling chilly. The horseback riding is beyond most of the patients, and even that exercise, indulged in for hours, is tiring to the sick, so that most of them, left to themselves, will walk and walk to keep warm. They thus get themselves tired and worn out, and often bring on fever, to their harm. Yet these very people find it natural and comfortable to ride in an open carriage on the same cool days that they would fear to sit on a porch.

It is one of the curiosities of the psychology of invalidism that it never occurs to the patient, unless he is told of it, that he can wrap himself in warm, thick clothes, put on mittens and overshoes, and put a heavy lap-robe about his legs and feet, exactly as he would if going driving, and sit or lie on a porch or on the ground for hours, and get all the advantages of a carriage ride safely and without its expense. The physician must go into all these details with patients, and many times over if necessary, to help them to the benefits of outdoor life. The delicate patients should lie on a cot or a reclining chair, as their condition requires.

Some of the patients are so literal that they will try to carry out their directions regardless of all variations in conditions, and often make themselves very uncomfortable in consequence. Told that sunshine is good for them, they will take it in its intensity every hour of the day. The patient should

lie or sit in shade or sun as his comfort requires. He must, if possible, be comfortable at all times. I have often seen a consumptive torture himself for hours by sitting in the hot sunshine, because he supposed it was his duty, and had not the acumen to know that all prescriptions for the sick are to be taken with some measure of common sense.

A tuberculous patient ought to sleep with a slight zephyr of air moving over his face. The physician may be accused of recklessness and cruelty in advising such a thing, but the fact is that one can sleep out of doors with the wind blowing over his face at any time without taking cold, provided his body and head are warm. If these proper precautions are taken, you may defy any patient to take cold. Most patients can be educated to sleep in the open, to the point where they will feel lost without a little movement of air over their faces. Soldiers sleep under tents or trees, or out under the sky with their blankets wrapped about them, and rarely have colds. Let them go home and sleep in rooms with closed windows, and they will soon begin to sneeze and cough.

If a patient sleeps in a very cold place or in the wind, he should wear a night-cap. The best kind is a knitted jersey affair that may be easily drawn over the head. If it is very cold, he should sleep between woolen blankets. He must be so wrapped

up and protected that he can sleep with the temperature at zero without discomfort. After he becomes adjusted to it he will thank you for the delights that you have led him to. Occasionally, if an afebrile patient feels cold, he will have what he terms rheumatic pains; they are generally merely neuralgic pains, mostly in the muscles, and will rarely occur if the patient is constantly warm, unless his digestion is out of order in some way.

The patient sleeping in a cold room should, if possible, have a warm place in which to dress, although this is not indispensable, provided he has good vigor and is able to dress rapidly. For the weakly ones with poor blood-making powers, who tire and breathe rapidly on exertion, we ought to invent clothing that requires little change on rising from bed. For this class of patients of both sexes the ordinary day clothing involves a wickedly useless waste of time and strength and heat in being put on and taken off. Any nurse or patient can devise a set of garments that will considerably minify this waste, provided the patient will pocket his pride and forego his ambition to appear dressed (and in bed even) like well people. The day garments should be fewer, simpler, and looser than is fashionable; they should more resemble the bed garments; and some of them may be identical with the latter. There is no law against wearing thick pajamas both in and

out of bed; and a single long, thick gown will cover and protect the body both in and out of bed. The common multiplicity of garments is, like appetite, something provided for the well; for the sick they may be a grievous and a useless burden, as they always are in the face of cold and fatigue.

Clothing should be simple and loose, should, if possible, cover the body equably, and should give a sense of warmth, not one of heat. Chest-protectors and abdominal bands are not to be advised unless the patients like them. No tight clothing should be permitted; corsets are usually a nuisance for a tuberculous woman; and tight collars and shoes and heavy head-gear should be tabooed permanently. There is a vast amount of useless cough at night, by some patients, due to the fact that the clothing over the neck, shoulders, chest, and arms is thinner than that worn by day. This should never be permitted; more rather than less should be worn at night.

The quantity of clothing is a great bone of contention with many of the younger women patients and a few of the younger men. They often declare that they are warm and feel warm, even in cold weather, with garments so few and so thin as to terrify their mothers and sometimes their doctors. They make this declaration, too, when their hands and noses are blue with cold; yet they protest their

candor, and that they have no sentiment against more clothes.

In connection with such cases, it is well to remember a few truths of human nature as well as of human pathology. One is that we rarely take cold solely from lack of clothes, but often from debility, fatigue, indigestion, and lack of excretion from the body. These thinly-clad youths do not often appear to suffer injury solely from their cold extremities and noses, but they do from other conditions named. Then, it has a harmful influence on the spirits of such a one to nag her perpetually about her clothes; it conduces to spiritual rebellion and consequent failure of digestion and sleep. She might, perhaps, be better off developing the qualities of the aborigines as to her clothes, than have dyspepsia and insomnia. On the other hand, it is perhaps true that such lack of clothing may bring on or hasten Bright's disease in a tuberculous patient. It is better to have the skin warm and near the sweating point, for the sake of its function as an excreting organ.

On the psychologic side it is true that vanity and foolishness as to appearances control many of these simple people without their consciousness of the fact. They fib about their sensations as easily and as blindly as a girl denies that her corset is tight, or a boy that his shoes bind or that his

collar is uncomfortable. Besides this, it seems to be a normal mental trait of many sensitive unathletic women to hate physical sensations of warmth and of perspiration. It is a quality of the neurotic, is temperamental, and can hardly be argued out of a woman. But the excessive touchiness to a sensation of heat produced by clothes is to a large degree one of unnecessary sentiment; even neurotics get over it easily if they find the clothing is inevitable.

I suppose it is an uncontrovertible truth that any severe strain on the system to maintain its body heat in cold weather may lessen its power to resist tuberculosis. So it is best to insist on a proper amount of clothing, even if it does cause some little mental anguish.

It is not important that the skin clothing should always be of wool, contrary to the general impression, although this is a most proper fabric. Silk, cotton, and linen will do well enough, if they are woven loosely, so as to contain many air spaces.

The question of baths is a worrying one to some consumptives. Many good people seem to feel that they are guilty of a mortal sin if they do not wash their bodies all over every day, and that somehow if they are always clean they have a right to expect to be well; also that the something called the stopping of "the pores of the skin" is fraught with the most dire consequences, which baths prevent.

Unfortunately, no such theory will stand; for many very filthy people seem to get on quite as well as those who bathe every day. And no stopping of the pores of the skin by any ordinary uncleanliness of the surface seems able to interfere with the free flow of perspiration whenever the conditions are otherwise favorable for that function.

Yet it is probably true that a daily bath is beneficial to a moderate degree, provided it does not tire the patient unduly or chill his body too much. It carries away some of the superficial epithelium, and in the taking of the bath some manipulation of the surface tissues is produced which has a good effect. But the bath never can be reckoned as of much value when compared with proper food, rest of the body, and a supply of pure air and other physical comforts. Well-selected tonic medicine is worth incomparably more than baths; and when the bath is taken at the expense of needed physical strength, as well as when it leads to shivering of the body from cold — often lasting for an hour — it is worse than useless and ought not to be resorted to often.

It is rational to suspect that, by reflex action, stimulation of the skin to just the necessary degree by baths containing some stimulating substance, such as mustard, capsicum, or carbon dioxid, might do good if it were to be used regularly and for a long time. But this cannot be asserted until long and

careful trial has shown it to be true. Unfortunately, most of the experimentation with baths has been done by specialists in hydrotherapy—a circumstance not conducive to unbiased reports.

Rubbing of the skin thoroughly with a coarse, dry towel is a measure nearly or quite as conducive to good hygiene of the surface as any bath, while it is safer for most consumptives.

One of the very important things is the diet. The patient, if at all debilitated, must eat oftener than usual, preferably six times a day. One need not dignify all these eatings as formal meals, and the patient must be disabused of the notion that he is expected to eat a great deal each time. He may not be asked to eat a total of more than he has taken in his previous three meals, but it must be distributed over six doses. And he must be forbidden to take at any time a large meal, as that might provoke an indigestion from which he could not recover in weeks. He should take an early breakfast, eat again in the middle of the forenoon, at noon, mid-afternoon, at nightfall, and before going to bed.

Many will declare that they have no appetite; that they cannot swallow food so often; that they will surely become bilious, or that they will vomit. But such fears are mostly groundless. If the patients try to eat six times a day, they usually succeed

They soon find that they can do it with as much ease as they formerly ate three times, and that they take considerably more in the aggregate. Most of them even come to like this way of taking their food; it helps them to learn that the thing called appetite, which is nature's device for well people, is not necessary in order to take a small amount of food, and that they can even ignore it.

Most squeamish patients eating three times a day have a poorly selected diet. They follow their whims, and so take many articles of low food value, like fruits, salads, green vegetables, and ices. At least they often do this for two meals each day, while for the other they eat inordinately of hearty foods, and in consequence often get indigestion. Eating from four to six times a day removes the temptation to over-eat at any meal, and abolishes the pathetic struggle to find something to please a morbid appetite to which the patient instinctively thinks he must cater. He now eats as a matter of routine, and even forgets whether he has an appetite; that emotion becomes a negligible element in his daily life.

The articles of food are important and should be insisted on. Four common articles are about all that is necessary — bread, meat, eggs, and milk and its products. Breadstuffs or starches should consist of stale bread or crackers, toasted if pre-

ferred, and, as a rule, eaten with butter. There is no need of rice, potatoes, or mushes of any description, although there is no necessary objection to them if they can be well insalivated. This latter is a difficult thing to do with any mush, and the bread should be eaten dry and stale, so as to encourage a free flow of saliva. Almost any tender meat is proper. The eggs should be soft-cooked or raw. The milk may be raw or pasteurized (160° F.), never sterilized (212° F.), and may be combined in numerous mixtures. These four articles are all that the human body needs, provided some of the milk is taken uncooked. If the milk must all be cooked, then it is better if there is a little fruit or some vegetables taken each day to ward off any tendency to scorbutus.

Patients will frequently object to what they are likely to call such a restricted diet; but it is not restricted. A vast dietary may be made out of these four articles. A dozen kinds of meat are possible. Rare or raw meat is the best, and some recent observers have offered evidence that raw meat is inimical to the growth of tubercle bacilli in the human body. Whether it shall be shown that this is always true, or whether the benefit is because the raw meat is more easily digested, there is certainly little or no objection to taking raw beef. It should be chopped fine, and it may be flavored in any way

to suit the taste — with salt and pepper, or mixed with nutmeg, allspice, cinnamon, lemon-juice, or anchovy, and spread thin between slices of dry bread in sandwiches. Patients come to enjoy it in this way. The eggs may be cooked rare in a variety of forms, the curdled egg[1] being the best, or they may be taken raw. One of the best forms is an egg-nog which combines milk and sugar with a moderate dose of some alcoholic stimulant. If this is properly prepared and flavored to the taste of the patient, he will usually relish it, especially if it is cold and taken through a straw or a glass tube. The best flavor is perhaps produced by one part of rum and four parts of whiskey, a tablespoonful being used to a glass of the mixture. Milk may be prepared in many forms, and stale bread may be made to appear in many different ways for the sick.

You must resort to various devices to make your patients eat. Many will declare that they cannot take milk — that it causes biliousness and leaves a disagreeable taste in the mouth. But the latter can be rinsed out of the mouth with a little water, perhaps flavored with something. Most patients can digest milk if it is taken in small drafts — that is, a teaspoonful at a time.

[1] An egg is "curdled" by being dropped (unbroken) into a small kettle of boiling water, which is at that instant taken off the stove and set on the hearth. In five to eight minutes it is sufficiently cooked.

A bilious subject should never drink milk in quantity, as it may form a mass of curd in the stomach; he should take it broken up in the way described, or, better, with some breadstuff eaten with it or between its mouthfuls, so as to dilute it. A little cooked starch — a small teaspoonful to a pint, as advised by Prof. W. S. Haines — or a cracker crushed and mixed with a pint of milk will prevent its forming into hard curds in the stomach. The same purpose may be helped by a little sodium bicarbonate taken just before eating. The taste of milk may be changed by the addition of charged seltzer water; and if there is any danger that it is not in prime condition, it should be pasteurized by being heated to 160° F., but it should never be boiled. Slightly sour or clabbered milk is sometimes relished and is altogether wholesome; buttermilk is a delightful thing to many invalids; and koumyss is another eligible form of milk.

With a majority of tuberculous patients specific directions must be given about the taking of food as well as about the food itself. Then the physician must not stop with prescribing the right diet and the right kind of eating, but must aid digestion, both of the proteids and the starch foods. For the former nothing is so good as pepsin with hydrochloric acid taken soon after meals; but for certain patients papoid and pineapple-juice are decidedly

beneficial. For the starch foods there is perhaps nothing better than taka-diastase and diazyme.

For patients with too much acid in the stomach, as shown by eructations of acid fluid or otherwise, an excellent thing is a dose of 20 to 60 grains of sodium bicarbonate dissolved in half a glass of hot water, and taken preferably half an hour before a meal. It is proper, however, any time after eating, when the proof of a sour stomach is present. Hot water helps many of these patients with their digestive troubles, a glassful being taken in sips shortly before a meal. Like the soda, it seems to aid the stomach in freeing itself from the debris of a previous meal, probably by coaxing the pylorus to relax.

Lavage should be tried in all cases of persistent gastric indigestion in tuberculosis. Many of these cases have an excess of acid, probably pyloric spasm, and consequent gastric dilatation, which this measuse is potent to correct. I have known cases to recover under the use of lavage, that seemed to be doomed to die until it was resorted to. The stomach should be washed out every day if it seems best, even oftener than once if required, although once is usually sufficient. Sometimes great relief is found in a lavage every second or third day. The best time for most cases is perhaps two or three hours after the last meal of the day.

By the lavage the particles of undigested food and more or less mucus are evacuated, the stomach is collapsed, and the patient generally sleeps better for it. He gets up hungry, to eat well the next day, taking six meals and digesting them. Many of the cases grow better daily after the lavage is begun. But, of course, in some instances no benefit results even after several trials; then it should be promptly abandoned as a treatment, for it is the rule that any benefits from this measure are experienced rather promptly.

Many consumptives have trouble with their bowels — sometimes very annoying ones (not due to tuberculosis of the intestines), that retard or prevent their recovery. It may take the form of pain, flatulence, constipation, or diarrhea, or these last two conditions may alternate every few days. True chronic intestinal catarrh may exist, with all its attendant conditions. This trouble not infrequently is due to lack of drainage of the colon and sigmoid. Fecal matter is retained in the pockets and tortuosities of these parts until it provokes diarrhea, after which constipation returns. Sometimes the patient takes a dose of physic to relieve the bowel, and this produces diarrhea, to be followed by worse constipation than before. This state of things is, of course, inimical to good health and good digestion. It too often produces ischiorectal abscesses and re-

sulting fistulæ, which rarely heal if the vitality of the body is low.

The best remedy for the condition is daily rather large warm enemas of normal salt solution (a heaped teaspoonful — 130 grains — of common salt to a quart of water) to wash out the descending colon and sigmoid, if not the entire large intestine. It will frequently stop a diarrhea, proving it to have been due to some retention in the large bowel, and stop the nagging discomfort of colicky pains that so often attend this disorder. At the same time it will often improve the condition of the stomach in respect to both its sensations and its digesting power.

The enemas should be used rather warmer than the body temperature — 100° to 105° F. (110° does not hurt the body), and can be used without danger. It is not always possible to use them, as they occasionally disagree with the patient in some way (most often by an absurd attempt on his part to retain the fluid for some time against a normal impulse to expel it); and we daily encounter the popular fallacy, as senseless as it is groundless, that there is danger of forming something that may be called "the enema-habit," and that will continue through life and be fraught with some dire calamity. If enemas are a comfort to the patient and help his digestion, they should be used

regularly; if they are not, they must be abandoned, but no whim of the patient, nor his esthetic squeamishness about taking them, must stand as an obstacle for an instant. The presence of tuberculosis of the intestine is no bar to the use of enemas, provided they relieve discomfort and aid digestion.

Massage is frequently beneficial in tuberculosis. It takes the place of exercise, and may be comforting to the patient. But the skin and muscles are often sensitive and tender; hence manipulations must be gentle and brief. Light rubbing of the skin with alcohol, or with oil after free washing with soap or alkaline water, may comfort the patient and do some slight good. There was a time when we felt sure that oils rubbed into the skin were to a large extent absorbed and so might nourish the system; but the experimental work of the laboratories seems to have proved that view to have been delusive. We now rub the skin with oil for the comfort of the patient or the good of the skin itself, and rely on the digestive canal to carry nutriment into the general system.

Light massage in one form or another may be beneficial because it diverts the patient's mind from his disagreeable thoughts and sensations, and takes the place of exercise which he is perhaps forbidden to have; and because it is good for the skin and is some help to nutrition. Nor should it be used upon

a part of the body that is tuberculous. Therefore all swollen joints, glands and other tissues, whether tender or not, should be avoided in such manipulations. Just the contrary is the tendency of nearly all who are engaged in giving massage. Many of them seem possessed of two cardinal and most erroneous notions: one, that they are in duty bound to rub out every pain and force away every swelling; and the other, that they are physicians, although they protest the contrary.

CHAPTER XIII

THE MANAGEMENT OF THE DISEASED LUNG

THE hygiene of the *diseased lung* itself is a subject of great importance. The wise and useful practice of the profession in treating all varieties of tuberculosis, except that of the lungs, has been to put the part at rest so far as possible. Just the opposite course has obtained in managing the lungs. The almost uniform practice has been, as soon as these organs become tuberculous, to urge the patient to take repeated deep breaths and "expand the lungs." Various exercises have been prescribed to this end. Little tubes have been used to breathe through, the expiration being made under pressure, so as to stretch the air-vesicles as much as possible; and both patient and doctor have been proud if the measuring tape has shown an increase in the circumference of the chest.

All these methods are harmful and wrong. There is no proof that the lung is an exception to the rule that tuberculous organs do best when perfectly quiescent; and there is much evidence to the contrary. A diseased lung needs to be put to rest so far as it can be. To this end there should be no deep breathing unless the affected lung can be put to

rest and the work of respiration be done mostly or entirely by the well one. Any obstruction to the outflow of air is certainly harmful, since it does violence to the lung-tissue; and no tuberculous lung should ever be allowed to expand and grow larger. Even cough should be suppressed whenever possible, in order to avoid the stretching and injury to the diseased tissues.

One of the results of violence to an ulcer on the surface of the body is to increase the amount of scar-tissue. The smallest scar forms where clean and sterile surfaces are brought together and kept still. If you prod a sore every day you should expect to see it heal slowly and with a large amount of new connective tissue that will contract afterward. The tuberculous lung heals, if at all, with more or less new connective tissue (*i. e.* scars) around and in the midst of the diseased area. That is nature's way of cure and we call it "fibrosis." The new tissue contracts after the cure, and causes more or less narrowing of the lung. The process is presumably conservative; but if too much fibrosis occurs, the contraction cripples the lung and may itself destroy life. The irritation of the disease starts the deposit of new tissue, and the great desideratum is to have as little fibrosis as possible consistent with cure; that is, to have a minimum of damage to lung-tissue after recovery.

There can be little doubt that, other things being equal, the amount of fibrosis bears some proportion to the measure of violence or motion to which the lung tissue has been subjected during the disease. If this is true, it is our duty to minify or abolish the motion of the diseased lung. The only way to abolish it wholly is to inflate the pleural cavity with sterile air or nitrogen gas after the manner of Murphy. This treatment is applicable to the incipient cases of unilateral tuberculosis without adhesions. The effect of it is to collapse the lung and stop all of its motion; then the pus that gets into the bronchi by the gentle pressure of the tissues flows out into the trachea, to be coughed up by blasts of air from the other lung. The diseased lung thus put to rest often recovers.

The treatment is attended with little pain, but the process of inflating the chest seems rather formidable, and most patients shrink from it. The gas is gradually absorbed, so that after a number of weeks a fresh inflation is usually needed. Sometimes three or four are required before the cure is complete. The patient experiences after the inflation the same sort of dyspnea that comes when a pneumothorax occurs suddenly; but this is rarely severe enough to make it unsafe for the physician to do the operation in his office and allow the patient to go home after an hour's rest. If the air or gas is

sterile, no infection takes place in the pleura; but an effusion of serum is an occasional complication of the treatment.

The necessary instruments are few. A rather large aspirator needle attached to a long rubber tube, to the other end of which is fixed any apparatus for drawing air through a large tube containing sterile cotton for the purpose of filtering the air, would do. A better plan is to have a cylinder of compressed sterile nitrogen gas that is let out into a little gasometer of one or two quarts' capacity, to be thence let into the chest. By this means the exact amount of gas introduced can be measured. It should be allowed to flow into the chest without any special pressure until the pleural cavity is fully inflated.

The needle should be sterile, and it as well as the tube, should be filled with the sterile gas; then the needle may be plunged into the chest-wall at the common point of election for aspiration of the chest, and deeply enough to reach just beyond the chest-wall. A deep inspiration usually starts the inflow of gas and begins the separation of the pleural surfaces. The instant the gas begins to flow rather freely, the needle ought to be pushed deeper, to make sure that its point is carried fully beyond the wall of the chest, so as to prevent any subcutaneous emphysema — a thing that frequently happens. It

can be prevented to some degree by the after dressing of a hard pad (a roll of bandage lying parallel with the ribs is a good one) held firmly against the chest-wall by a stout bandage around the body. If the needle at first is pushed too far, it will enter the lung, draw blood, and fail to let air into the pleura; then it must be withdrawn slightly. The results of this treatment are not all that was at first hoped for it, but they are such as to stamp it as an eligible operation, and to add to the proof that effusions of serum and pus in the pleural cavity had already given us — that the putting of a tuberculous lung to rest is good treatment for it.

But the inflation treatment will probably be used in only a very limited number of cases. It will have to be restricted to (1) incipient cases of (2) one-sided disease, where there are (3) no adhesions, where (4) the patient will consent, and where (5) the doctor is prepared and willing to administer it. These conditions restrict the proportion of cases greatly. The vast majority of patients can never have the treatment, and these require rest of the lung as truly as any.

We can put the lung to partial rest by a variety of measures, always assuming that there is one sound lung to breathe with.

One of these measures is to repress cough by personal effort, especially the useless cough. This

can be done to a large extent by the will of the patient. He can try to prevent the cough except when loose phlegm is present in the trachea or large bronchi, and can succeed half of the time; the other half of the time he can prevent the intense, hard coughing efforts that are preceded by deep inspirations. The process is psychologic, and it will succeed often. There is a vast amount of wholly unnecessary coughing done by these patients at the behest of tickling sensations in the throat, which, if the cough were suppressed for a moment, would disappear. Waiting for a few minutes, the phlegm becomes so loose as to be raised by a slight effort — sometimes by the maneuver of hawking. Spraying the throat with soothing solutions, as of a one per cent. solution of carbolic acid and menthol in albolene, or gargling with a weak alum solution, may help the patient to suppress the cough. The nebulizers are better than the spray machines for the oily medicaments, the particles of the latter being rendered more minute.

Another method of great value in reducing the labor of expectorating is to cough at the end of a profound expiration. Then the bronchi, and cavities if there are such, are partially collapsed, and through their narrowed channels a mass of a given size can be pushed out by half the force of air-blast that is usually required. To cough at the

end of a deep inspiration is to increase the force and volume of air required to move a mass of phlegm toward the exit (since the air-channels are widened), and tuberculous patients ought to avoid it as far as they can. Any patient who will try the two methods alternately and faithfully will be convinced of the value of coughing at the end of expiration, may save himself considerable discomfort, may spare his lung-tissues, and thereby favor recovery from his disease.

We have many of us long advised patients to cough, and to cough forcefully, so as to expel the purulent phlegm, on the theory that its retention produces fever. I am now satisfied that this is an error, for pus in a bronchus does not to any extent cause fever. It may be long retained in bronchiectatic cavities with almost no fever. The fever-causing pus products are substantially always in cavities outside the bronchi, or in some of the wall tissues of the bronchi themselves, and beneath the mucous membrane.

Another useful maneuver is, while horizontal, to lie on the well side, so as to have the force of gravity to favor the flow of the phlegm toward the trachea, and thereby minify the cough. Sometimes a whole night may thus be spent in sleep without cough, the discharge flowing by its weight into larger and larger tubes and partially drying

on their walls without irritating them. It is loosened by the activities of the morning and the taking of fluids, which cause a slight flow of serum upon the mucous membrane; then it is all easily coughed up in a few minutes. The mucous membrane proximal to the lung lesion becomes in a measure tolerant of the presence of this morbid material, but the parts distal to the lesion are often so sensitive as to provoke a cough the instant any of the material invades them.

A general habit must be cultivated of breathing quietly — breathing more rapidly, if necessary, but never more deeply than usual. There must be no public speaking or singing, as these exercises always strain the lungs, and experience shows that patients who indulge in them are injured thereby. They are even worse than using the breathing tubes, which are sufficiently harmful.

The diseased lung can be forced into partial quiescence by means of adhesive bandages applied about the chest to minify the motion of the ribs on the affected side, with the addition sometimes of a wide band around the abdomen to restrict the excursions of the diaphragm. This is a method that has often been employed to limit movement where, from injury or neuralgia or inflammation, a side has been in pain; and for that purpose it has been effective. It ought to be employed more in

diseases of the lung itself, where quiescence always tends toward recovery. When it can be carried out with some degree of continuity, it will, I believe, materially assist in the process of recovery by shortening the disease, lessening the amount of fibrosis,

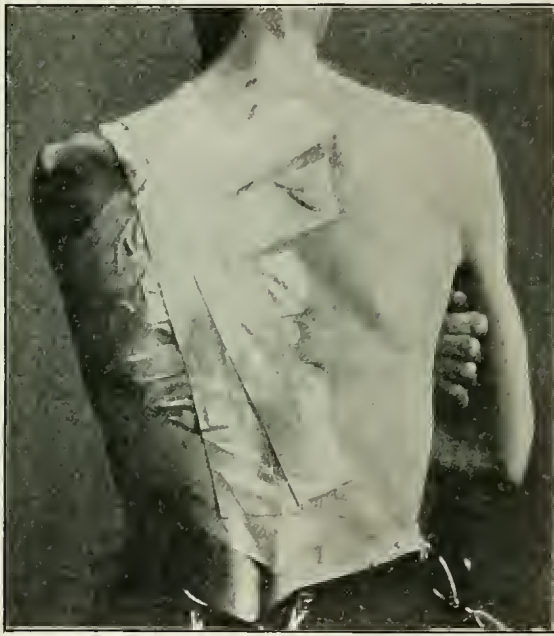


Fig. 3. Strapping the chest to restrict the action of a lung. (Rear view.)

and reducing the tendency to amyloid degeneration of important organs from prolonged suppuration. It produces in many cases marked amelioration of some of the annoying symptoms, and the benefit is often instantaneous. It stops the rales and rhon-

chi that keep many patients awake and annoy them into frenzy; it lessens harassing and useless cough, often to a marked degree; it relieves the sensation of fatigue in the side that many patients complain of. They feel from it a sense of support of the side that is grateful.

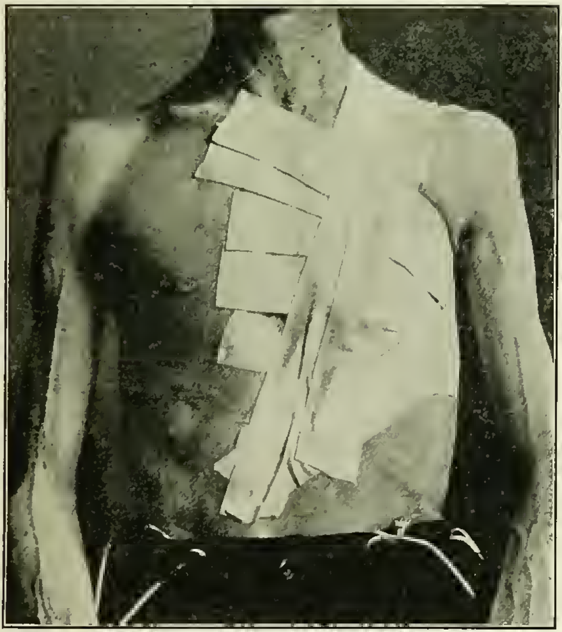


Fig. 4. Strapping the chest to restrict the action of a lung. (Front view.)

The strapping is best done with rubber adhesive plaster, two inches wide, passed about the chest below the axilla horizontally, and extending two or three inches beyond the center line on to the

well side. The first strip is best applied at the bottom of the chest, and the successive ones above this slightly overlap each other, so that when the dressing is finished the side of the chest is almost completely covered. The arm must hang vertical as the strips are applied, for if it is elevated, the upper edge of the plaster is almost sure to cut into the folds of the axilla when the arm is brought down; and to cover the space front and back above the level of the axilla, the strips must be placed diagonally, spread out in a fan-shaped manner, those in front beginning over the upper end of the sternum and ending below the scapula of the well side, those in the back starting over the interscapular space of the well side and terminating beyond the ensiform cartilage. Finally, two strips should be carried over the shoulder and brought down front and back to the lowest edge of the applied plaster, and be pressed firmly against it. The skin of the shoulder is easily irritated by the plaster, and would better be protected by a piece of cloth beneath it, for it is not necessary to have the plaster adhere to the shoulder; its object is to prevent motion by holding the shoulder down by its pull against the transverse plaster below.

Every strip of the plaster must be applied with the chest in profound expiration, and, except over the shoulder, each strip should touch the skin first at its center, the two ends being then drawn to place

at the same instant and pressed firmly until their adhesive material has taken a good hold.

The plaster remains in place effectively for a variable length of time, depending on the heat of the surface of the body, the amount of perspiration and oil on the skin, the condition of the skin, and probably on other and not well-known conditions as well. Usually it requires to be taken off and replaced at the end of about a week. By that time the plaster has crept a little, and its tissue may have stretched a trifle also. The imprisoned skin, too, has perhaps begun to show some irritation. A few pimples and spots of excoriation may have appeared, and the patient may have been annoyed by itching.

Dr. Charles Denison has suggested ingeniously that the shoulder of the well side be made a fixed point of attachment for the narrow ends of plasters, which are made some six inches wide at the part that covers the diseased side. This ought to prevent some of the creeping of the plaster; and experience may show that the method will be tolerated well by the patient.

After the plaster has been removed, some simple dusting powder may be applied for a day or two if the irritation is at all severe, when fresh plaster should be put on again, and so on for many months. The skin, after the first few applications of the plaster, may grow tough, so that the annoyance

is much reduced. But if the tendency to irritation persists, an adhesive plaster containing some oxide of zinc may be used. This seems to agree with a vulnerable skin better than the unmedicated plaster, although it is rather more yielding. In removing the plaster the least discomfort is produced when, after cutting the shoulder strap, the whole mass is peeled off together, beginning at the front edge and pulling back along the surface of the body, and not at right angles to it. A quick, firm pull startles the patient a trifle, but really causes less discomfort than taking the plaster off slowly.

When abdominal breathing is extensive, the effect of any fixation of the ribs by the plaster may be almost neutralized by the vertical motion of the lung. Then a rather firm bandage for the abdomen will be necessary; but as most patients breathe almost wholly with the thorax, this will not often be required. For the purpose any simple firm cloth will do, when pinned at half a dozen points. It does not seriously embarrass the abdominal organs unless there is inflammation or tuberculosis within this cavity. Even when the diaphragm is fixed or almost motionless, fixation of the ribs of one side by any means whatever cannot completely put the lung at rest, since the mediastinum will move slightly with each movement of the other side of the chest; but this is only a slight drawback to the value of the method here described. If it were not

for the annoyance the plasters give the skin, I feel certain that this means of lung fixation would come into general use in unilateral cases of consumption.

A better fixation apparatus is a perfectly fitting, unyielding jacket or splint embracing one side of the chest. When accurately applied and well fitted to the chest, it materially reduces motion, and is so far a most useful device. It has the advantages that it does not irritate the surface and that it maintains a uniform degree of pressure continuously. Its drawbacks are: some difficulty in having it well made and properly fitted; the repeated tinkering often required before it will fit firmly without annoying some part or spot; some nervous discomfort for a few days from a sense of imprisonment on beginning to wear it; and at first the annoyance at having to wear it at night — for it ought to be kept on constantly, or nearly so, to have the best effect. A little patience and perseverance usually remove all these obstacles in a few days.

The apparatus may be made of any light material, as thick leather or yucca wood, supported and kept in position by stout steel bands, which may be bent to fit the body after the manner of the steel of a truss. A plaster cast of the chest is necessary over which to fit the splint; such a cast helps, but can never enable one to make a perfect fit for the chest in life and activity. More or less adjustment will probably always be necessary after the instrument

is made, before it is both efficient and comfortable. Once adjusted properly, it can be worn for months without change.

No one but a superior brace-maker is capable of fitting successfully such an apparatus as is here described.

Fig. 5. Author's jacket for reducing the motion of one side of the chest (made by the W. W. Sweeney Co., Los Angeles, Cal.).

This jacket is best worn over a smooth-fitting undergarment, which should be changed frequently. Even then, perspiration will sometimes dampen the lining of the apparatus, and it is sure to have at times a musty or sour odor. This can be corrected any time by heating it to a safe degree by cautiously

holding it for a few minutes over a fire, or over a kerosene lamp with a large flame.

Finally, a resourceful patient can develop the power and create a habit of repressing to a moderate degree the action of the muscles of one lateral half of the chest, thereby reducing the motion of that side and rendering the lung relatively quiescent. It requires for a time almost constant minute attention

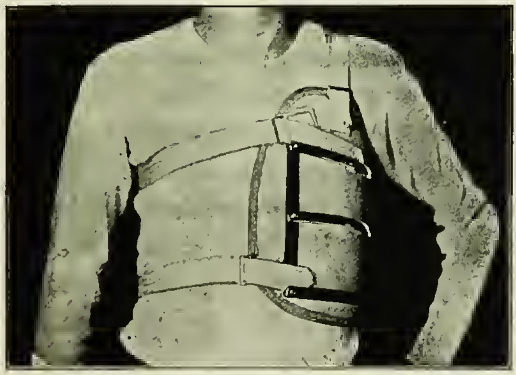


Fig. 6. Author's jacket applied.

to the subject, a good deal of will power, and a peculiar mental control of the muscles, in order to be able to form thus a new habit in breathing. No very sick person has the power of attention that is required, and perhaps no one is capable of developing the habit of one-sided breathing to such a degree as to carry it on perfectly in sleep. Probably few patients will ever succeed in using the measure to any great effect; but the effort ought to be made, and those who accomplish it deserve to recover.

CHAPTER XIV

TREATMENT, CLIMATIC

One of the best of all treatments for pulmonary tuberculosis is a new climate — and the best climate for the disease. The best for the particular patient is usually some other than the one in which he contracted the disease. No climate is exempt from the initial occurrence of tuberculosis. The disease originates in all the "resorts" for its cure. If any place had such exemption, it would be the refuge for all people who suppose themselves predisposed to the disease; but certain climates are better than others for patients who have acquired it, and such benefits as they possess every patient ought to have if he can. There is a good deal of confusion, both with the profession and the people, on this whole subject, not only as to what are the best climates for consumption, but as to why and by what elements any climate commends itself as a residence for those who have the disease. So far as our knowledge goes, there can be but a few elements involved in the variations of climate anywhere in the world. It must be a matter almost exclusively of the atmosphere near the surface of the earth, and includes the elements of temperature, humidity,

weight (barometric pressure), motion, and purity of the air. The humidity covers much of the question of fogs and storms, and so of degree of sunshine; and weight is concerned with that of altitude; while temperature explains and defines much of the changeableness of weather. It is evident that altitude, latitude, and the presence of mountains and large bodies of water are the chief factors that determine the qualities of any climate. These elements given, and a careful study will almost certainly enable a student of the subject to say what the climatic qualities of a particular region must be, showing that there cannot be any very mysterious quality in any climate. That is, the features of all climates are rational; and it is rational that some should be more and some less fit for those sick with particular diseases. This is especialy true of pulmonary tuberculosis.

There can be no question that one of the good effects of any climate to which a consumptive may go is its newness to him, and his hope and belief that it is to do him good. It is a change, and a change is *per se* beneficial. But there are certain qualities of climate in particular regions that specially commend them to these sick people and make their lot in living easier. The one of chief value is mildness — absence of any disagreeable quality that is depressing to the patient, so that he not only can,

but is by the very weather invited to, spend much of his time out of doors. Outdoor life is the most valuable treatment of tuberculosis extant; hence any place where the weather makes it easy for the patient to have with comfort this surpassing remedy all the time, is salutary for this disease. And I have no hesitation in saying that the major part of all the benefits of climate for consumptives is due to this one fact; no other influence is at all comparable to it.

But there are qualities of atmosphere that are valuable independently of mildness and purity. Chief among them are the low barometric pressure of altitude, and dryness. Low relative humidity of the atmosphere has long been held to be beneficial in consumption, and probably with good reason. The patients do better, other things being equal, in such climates; and this is the best evidence of all. In the dryer air there is less expectoration, at first probably due mostly to reduction of the watery elements of the phlegm, not so much to any decrease in the pus. If the pus is lessened at all, it is an advantage, since the formation of it for long periods is an injury to the system. And the reduction of cough is a good thing, because it is always more or less of a strain on the diseased lung-tissue, which ought to be kept still; if the cough is severe, the strain is considerable, and constitutes

an amount of physical exercise that tires the system and perhaps elevates temperature. The fever should be expected to be higher on days of a good deal of cough. Reduction of the cough and rest of the lung and muscular system tend to recuperation of the powers of the body, and so less pus is finally formed, with less danger of injury from its absorption.

But not all of the benefits of dry regions can be due to the absence of humidity, nor are all the disadvantages of so-called bad or poor climates for consumption due to the presence of it; for some of the latter have at times as little moisture as some of the better ones. The arid regions of the United States — namely, Colorado, New Mexico, Arizona, and Utah — are reputed of great value for tuberculosis because they are dry. The inland regions of Southern California enjoy a similar reputation, founded somewhat on their dryness. Patients are sent from the East and Middle West to these regions constantly, especially in winter; they are also sent from San Francisco, Oregon, and Washington. The actual humidity in these dry regions in summer is considerably less than that of the Middle West, but in winter the difference is less, and very little. The regions of Lake Michigan, Minnesota, and the Dakotas show as little actual moisture in the air of winter as most of the arid regions. San Fran-

cisco has less actual humidity than Southern California, averaging winter and summer, and in winter as little as many places in Arizona, New Mexico, and Colorado. In the month of January, for ten years, the foot-hills region of Southern California had two grains of water to each cubic foot of air, and Little Rock, Memphis, and Norwalk had the same; but Milwaukee, Denver, Deadwood, Santa Fé, and Las Animas had only half as much, while Des Moines, LaCrosse, and St. Paul had even less than half; San Francisco had the same as Los Angeles, while Boston and Portland, Me., had 40 per cent. as much. In July, however, all the arid localities had a marked reduction as compared with all regions east of the Missouri River; Los Angeles had 25 per cent. more than San Francisco, but 11 per cent. less than St. Paul and Chicago.

These facts show that there must be some quality of the arid regions other than the actual humidity that is important for the sick. That quality is the low relative humidity, the low percentage of actual saturation of the air for a large part of the time. It fluctuates with the time of day. In the night and early morning, with low temperature, it may be 90 to 100 per cent., while during the day and evening, with higher temperature, it may be only 60 to 80 per cent. of saturation; yet the difference in the amount of water per cubic foot of air may be

only the fraction of a grain, the increase being in the evening, when the relative percentage is lowest, and being due to increased evaporation during the day. Warm air takes and holds more moisture than cold air, and in geometric ratio as the temperature rises. The more moisture the air takes up, the lighter it is; the vapor of water is therefore lighter than air.

The thing the sick need most is such a degree of humidity and temperature as will give most comfort, and most assist the powers of their physiology, and relative dryness often helps in this direction. Low relative humidity seems unavoidably connected with frequent or average high temperatures; but these latter are endurable if there can be free evaporation from the body, and low relative humidity favors this, regardless of the actual water in the air; for evaporation does not depend on how much water the air contains, but on how much more it can take and hold. Radiation of heat from the body is easy with the temperature at 50° to 70° F.— *i. e.* 25 to 45 degrees below body temperature — regardless of humidity. If the air is nearly saturated with moisture and not too warm, it seems to our sensations soft and balmy; with much less moisture it is not uncomfortable and is more invigorating. In air relatively dry, perspiration evaporates rapidly and so reduces body-heat;

with the air at 50° to 60° there needs to be little perspiration unless there is free exercise; but, with the temperature 90° to 100° or over, the perspiration is profuse, and must be carried off rapidly in order to keep the body-heat down to the plane of comfort; and if the air is near saturation point, evaporation is reduced or abolished, and great discomfort as well as danger to pulmonary invalids is sure to obtain.

There is a good deal of fluctuation in relative humidity at different times of the twenty-four hours in dry regions, depending on the temperature; and the temperature fluctuates greatly. As the temperature falls the saturation point is approached, and it is often reached or exceeded for a short time in the night or morning; then the moisture becomes visible in clouds, fog, or rain. And in dry regions the air is rapidly chilled by the most remarkable radiation of heat from the surface of the earth the moment the sun disappears in cloud or night. This phenomenon results from the marked diathermancy of the air due to its dryness. Moist air is an obstacle to the radiation of heat as well as to the transmission of light; the stars are brightest in a dry atmosphere.

It is fortunate that the highest relative humidity of dry countries occurs at the time of lowest temperature, so that there is no discomfort from heat.

When the air temperature is near that of the human body or above it, the relative humidity is so low that temperatures of 5 to 10 degrees above the body-heat are hardly noticed, so rapid is evaporation from the skin. Hence it is true that the perceptible temperature of the air may be very different from that shown by the thermometer. In dry districts the perceptible temperature is always below the reading of the instruments on hot days; and once the United States Weather Bureau undertook to record the range of this difference, but it has been abandoned as being perhaps difficult of scientific measurement.

There is no reason to think the daily brief approach to the saturation point does any particular harm to the sick, provided they clothe or otherwise protect themselves against the cold; only they cannot safely protect against it by shutting out the fresh air even if it be loaded with fog. The fog is a bugbear to many sick people, and there is a great popular prejudice against it; but it does little, if any, harm if people will only clothe according to the temperature. Fog may be disagreeable by the dampness left on the clothes and body, that must evaporate and cause further coolness as soon as the sun warms the earth; as well as by obscuring the sun. But the moment the fog appears, if it occurs in a warm region, there is often, if not always, actually less water present than there was

before; for the very force that usually produces the fog is a mass of cold air, low in dissolved water, rushing into and mingling with a body of warmer air containing much more water, so that the result is less actual humidity.

We ought to caution all lung patients in dry climates to so clothe themselves at all times, especially out of the sunshine, that they will be and feel warm constantly, except when they are chilly from the rising tendency of fever. This last no amount of clothing will prevent; it is a false sensation due to the pathologic process set up by some absorbed poison. The caution about clothes is most needed by the ambulating patients who have but slight sensations of cold at night and in cloudy weather. They should wear all the clothes they can, without positive discomfort, not simply what they must wear or may think they need.

A large amount of sunshine is desirable. The patients enjoy it if the weather is not too hot, and it helps to keep them out of doors, which is the great desideratum. Rainy weather is objectionable if the rain continues for many hours at a time, because it keeps the patients housed, and prolongs the period of atmospheric saturation point; the former is bad, and the latter may be. That the latter is not necessarily and always bad is shown abundantly by a large number of recoveries from pul-

monary tuberculosis in mild and enjoyable climates on the sea-coast, on islands of the sea, and on shipboard. Santa Barbara and San Diego, in California, not to name many other places, have furnished sufficient examples of this sort.

While the balance of proof is in favor of a dry climate for consumption, the balance is not very large, for many patients have appeared to do better in moist and mild climates like those of the coast of Southern California and the north shore of the Mediterranean Sea, as well as out to sea in mild climates. Here the patients complain less of dryness of the respiratory passages and have less of the annoying, dry, and useless cough; and as the mildness permits them to live much out of doors, they are able to have the greatest benefit of any climate.

Altitude has long been held to be beneficial in pulmonary tuberculosis, and probably with good reason. An elevation of three to five thousand feet above sea-level often starts a process of better nutrition in patients who come from lower levels. The change sometimes begins an improvement that goes on to recovery. The reason for the benefit is a matter of some speculation. A favorite theory long held was that the more rapid and deeper breathing required by the rarefied air expanded lung vesicles and so helped to cure the disease. But I be-

lieve this theory is untenable, because it is no benefit to the diseased lung tissue, but the contrary, to have it expanded extremely. It is well established now that as one journeys from a lower to a higher altitude the red corpuscles of the blood increase in number, there being perhaps a slight reduction in their diameter. In the time required to travel quickly to the top of a high mountain the number increases by some thousands for each cubic millemeter of blood. But not all the increase shown by the usual examinations of the blood is real; some of it is due to a rapid flow of the red corpuscles from the deeper vessels to the surface of the body.[1] Such rapid changes in the blood elements are a hint of further changes as vital in the other physiologic conditions, that can explain any benefit to the sick far better than a supposititious influence on the mechanics of the lungs, due to rarefied air.

The cases that do best at high altitudes are incipient ones; more advanced cases often run a rapid course to death. Where the lung-tissue is much crippled by lesions, whether of infiltration, cavities, or fibrosis, high altitudes are apt to depress the patients, and they had better go to lower levels. But the common fear of hemorrhage from the altitude is, I believe, quite groundless; bleedings are as likely to occur at sea-level as at the mountain-

[1] Campbell and Hoagland: "The Blood-count at High Altitudes," *Am. Jour. Med. Sci*, Nov., 1901.

top. That is, no relative increase of blood-pressure is likely to occur at the seat of lesion because of the altitude. When the blood-vessel walls are invaded by tuberculosis and become fragile, the normal blood-pressure will cause them to break, and hemorrhage will occur, whatever the altitude. Then the problem is to minify the damage and danger from the bleeding; but the bleeding to some degree will be inevitable.

It is claimed by some that high altitudes induce great nervousness in invalids, and are for this reason objectionable; but I am satisfied that this danger is much overrated. Doubtless such an effect does occur to some patients after a time, but it must be rare, and almost solely after a residence in the altitude for several months or years. The greatest benefit is probably experienced in the early months of residence at an elevation; and this good influence can nearly always be had before any bad effects come to the nerves.

In the United States there is every variety of dry climate and all degrees of altitude, and these qualities are in many cases in combination. The highlands of Colorado, New Mexico, Utah, and Arizona are all arid to a remarkable degree. The mountains of California are mostly less dry, but dryer than the regions east of the Missouri River; while Arizona and Southern California have some

regions at or about sea-level, some above and some below it, that are as dry as any habitable place on earth. At the same time we have along our southern Atlantic and Pacific coasts many places where a mild sea climate can be found in perfection. There is a medium climate, less dry than the arid lands, but more so than the sea-coast, with elevations approaching two thousand feet, that is grateful to a large proportion of pulmonary patients; it is beneficial to many of them as well. This is represented by such spots as the Adirondacks in New York and the foot-hills of Southern California from Pasadena to Redlands.

Patients often dread low temperatures of winter, even when they are in an otherwise ideal climate. But there is little reason for the dread unless they are too weak to endure the cold under the conditions that are necessary. It is easy for any patient of fair vigor to endure even zero weather, sitting out of doors well wrapped against the cold, or asleep in his room with his windows open. The air in such a degree of cold is always dry, freer from moisture than the air of the warm dry countries, and strong in oxygen from its concentration by the cold. The only objection to the cold is that it is less agreeable and convenient than the warmer air, and requires better heat-producing powers in the body. Patients can be up and go about easier and

with more pleasure in milder weather; it is doubtful that it is really any better for them than the cold, provided that in the latter they can be out of doors enough.

In connection with this subject there is one signal danger that must not be forgotten. The tendency is always strong for the patient and his friends to regard the climate he goes to as the only thing necessary for his recovery, and to neglect any good, sustained hygienic care of himself after he arrives there. He often goes alone, without friends, lives among strangers, is homesick, has no fit course of conduct given him to follow, and takes the advice of every lay acquaintance he makes, in the most implicit faith that they know the right way and are worthy of being followed. As a matter of fact, such lay advice is usually the worst sort of vicious nonsense that can be imagined; as, for example, that the night air is bad to breathe; that the patient should not be out of doors later than four o'clock in the afternoon, should not venture out till eight o'clock in the morning, and that it will not do to have his room ventilated so as to cause a draft of air about his person; that he should take as much walking exercise as possible, and should not sit down out of doors in the cool weather unless in the sunshine. These several pieces of advice are not only wrong, unscientific, and harmful, but if

they had been conceived in a deliberate intent to do the sick as much injury as possible under the guise of kindness, they could not be more fitly stated. Such advice is given so uniformly and by so many people that it is small wonder the patients believe it, which they generally do unless they have been put on their guard by their physicians. And it is one of the curiosities of mind that among the lay people these errors should be carried so faithfully from mouth to mouth for years.

Then the sick, away from home and after climate, sometimes follow their own whims, appetites, and desires so far as possible, and are more concerned about their entertainment than for the things that will help them recover. They make their absence from home a matter of sightseeing rather than a systematic campaign against tuberculosis. As a result, many a one loses half the good he might have because he fails to carry out a perfect hygienic course with his climatic treatment. He goes to a climate where he can find a better air to breathe than he had at home, and then shuts himself in a closed room and bad air for more than half the time. If then he fails to improve, he blames the climate, and loses the time and money he has spent so lavishly to get well. It is a most pathetic witchery of errors, of which the profession is not wholly faultless.

If patients cannot be provided against homesickness and be sure to take all legitimate advantage of their time and opportunities in their climate-seeking, they had much better remain at home, where at least they might be happy and be kept under conditions of good hygiene.

With the best intentions, and acting on the best of advice, the patient often does himself injury by occasionally forgetting his rules and regulations. He will watch his regimen and daily round of care of himself for a month at a time, gaining from day to day; then he will forget and over-exercise for a single hour or over-eat at a single meal and get indigestion, thereby losing all he had gained for many weeks.

The effect of good climate for consumptives ought to be added to — never take the place of — the very best measures of general management and treatment, which should continue without a break for months and years. These are the patients who, above almost all others, cannot afford to forget and make mistakes, even occasionally. But it is a melancholy fact that they seem fated to make mistakes in their own care, both frequent and grave.

There seems to be something in the mere fact of climate-seeking that tends to make people forget that climate is not the only thing necessary for the sick. As a result, these people do some very queer

and illogical things. When one of them moves to a climate thought to be good for his disease, he expects to experience benefit in a few days. If he fails of this, he is not only unhappy, but he is sure in a short time to lose faith in the new influence, and perhaps will make several moves in rapid succession to different localities, even of the same general climate, always blaming the one where he gets worse and praising the one where improvement begins.

In this way different localities acquire reputations, both good and bad, which they do not deserve, and patients put themselves to vast expense and inconvenience for nothing, or worse than nothing. Such errors could easily be avoided if people would remember these most incontrovertible truths: that no sudden marked benefit ever results solely from any climate whatsoever; that all climatic advantages come slowly through the months; that no relapse or rapid getting worse ever comes of the legitimate effect of any climate; that vicissitudes of weather in any climate — of heat and cold and wind and storm — may any day harm an unprotected patient; and that there is no magic or medicine that is known of as inhering in any climate, but only the possibilities of clean air to breathe, and such physical influences of air as may enable the normal physiologic powers of the sick to have the

best chance and the freest field for the cure of the body from disease. Nothing is gained by demanding of climate more than it can do, more than it is reasonable to expect of it. Much is lost by forgetting the weighty things of the laws of human physiology.

CHAPTER XV

TREATMENT, MEDICINAL AND LOCAL

THE medicinal treatment most constantly demanded in tuberculosis is that with tonics. This is the best for nearly all invalids who are below their par of general vigor, and most tuberculous patients are below it. But some of them are quite up to their usual level, even above it, when measured by any known standard of physical vigor; they are below simply and only in some unmanifest power of resistance to the disease tuberculosis; they apparently resist everything else as well as anybody can. Whether for this class ordinary systemic tonics are as useful as for other patients cannot be said, and it is rather doubtful; but we do not know of any other medicinal treatment as useful for them.

Tonics produce different and varying effects on the several functions of the body. Some benefit most the digestive organs and improve the powers of blood-making, and through that the general vigor; others appear to increase the strength of the body directly and to add to its power of resisting adverse influences; others appear to affect more the nerve force, and to increase mental poise and the power of normal nerve-action, and the ability to

sleep and be refreshed. As to the action of many of them we are very ignorant, and perhaps as to all of them. We know that they affect different people in different ways, dependent on individual idiosyncrasies. Some tonics that agree perfectly with certain persons wholly disagree with others, and produce in exceptional cases the most unexpected effects, both good and bad.

Tonics differ in their rate of action. Some are slow, others are rapid. Cod-liver oil — if it is a tonic and not merely a food — is very slow; alcohol, which to certain patients is a positive tonic, is very rapid; while iron and all the numerous bitter and other tonics come in between in varying rates of effect on the system.

Probably the tonic that agrees best with the greatest number of the tuberculous is a mixture of some form of iron with bitter principles from two sources — the nux vomica bean and Peruvian bark; and the most eligible preparation is a mixture of iron with quinin and strychnin. But the dosage of these medicines as they are usually prescribed is not very well adjusted. The quinin and iron doses are apt to be too large, and the strychnin too small. Quinin should not be given as a tonic, except for a few days at a time, in doses as large as two grains three times a day; one grain is enough, and half a grain is better if it is to be given long — and it is usually

best to give it long in tuberculosis. On the other hand, strychnin is usually given in doses so small that, even when long continued, the best effect is not secured; 1-30 grain is better than 1-60 for brief medication, and the latter is not too large for long continued use. Any unirritating form of iron will do; a favorite with me is the reduced iron (ferrum redactum), but the citrate and the peptonate of iron are eligible, and perhaps the last is the best. The combination may be taken for a long time with benefit, or the articles may be given separately and be changed from time to time.

Arsenic in the form of arsenate of sodium is a safe medicine and a tonic for some patients, and may be continued for a long time if it agrees. Cacodylate of sodium promises to be a valuable remedy, but there are drawbacks to its use, and its value is yet to be proved. The mineral acids are often useful, the best being the hydrochloric or the nitrohydrochloric. One of these with tincture of nux vomica makes a most useful aid to digestion for some patients when taken after eating, especially when preceded by a moderate dose of bicarbonate of sodium greatly diluted and taken before the meal. The effect of the latter is probably, by neutralizing any excess of acid in the stomach, to facilitate the exit of the debris of a previous meal into the duodenum, preparatory to the digestion of the new one.

The malt preparations have been greatly lauded for their tonic powers, but, except for their aid in the digestion of starch foods, they are not very valuable. Nor is cod-liver oil of much use in any way. It has a certain food value, which is slight, owing to the small amount taken, and the medicinal effect is hardly proven to exist. Really the small value that it possesses is scant compensation to the patient for the months of patience he must exercise in taking a disagreeable medicine. Other fats, like olive oil and butter, are more agreeable substitutes, and probably nearly or quite as useful.

Various aids to digestion are often invaluable, as the pepsin and pancreatin products, the taka-diastase, diazyme, and similar preparations for the starch digestion. Salol, oil of cloves, creasote, guaiacol, and others of their kind have a certain usefulness in preventing fermentation in the intestines. It is not proven that any of them has a direct effect on or against the tuberculosis. Creasote, guaiacol derived from it, and their carbonates have been used in a routine way by a large number of practitioners, some of whom believe profoundly in the beneficial effects of these drugs. They have kept patients taking such medicines for months, even years, and sometimes in enormous doses continuously. That most of the patients have escaped harm from them so generally is a valuable lesson, but I am sorry I can-

not agree that the tuberculosis is retarded by them except as just indicated.

Chlorid of gold and sodium has been much used in America in the general treatment of tuberculosis, but we lack evidence that it acts in any way except as a moderate tonic. At one time it was thought to have some directly antagonistic influence to tuberculosis, but the theory is without proof.

Nuclein in various forms and nucleinic acid are worthy of trial for their possible power of increasing the resisting power to tuberculosis. It seems to be demonstrated that they increase the white corpuscles of the blood; that they increase the forces that destroy the bacilli in equal ratio is not so well demonstrated. Many physicians believe they have witnessed clinical benefits from these drugs, but no extensive tests have been made with a large number of cases, under circumstances that permit scientific comparisons with other treatments. The preparations deserve a more general use. They have the advantage of not being objectionable to the patient or harmful to any of his functions. My own preference is for the nucleinic acid, which may be taken in 2 grain doses between meals, and in conjunction with the ordinary tonics.

For the constipation laxative medicines are sometimes needed; but they had best always be given regularly, and in doses so small as to act as intes-

tinal tonics. Among these the most valuable are aloes, senna, cascara, and rhubarb. The doses should be adjusted to avoid a cathartic effect; and the addition to the laxative mixtures of belladonna to prevent griping, and strychnin or nux vomica on the theory of producing some good effect in conjunction with the laxative, is rather fanciful, as neither does any particular good in this way. It cannot be said, however, that they do any harm, provided the laxative is not required to be taken often enough to carry so much belladonna as to cause constitutional effects; these last are always disagreeable and wholly unnecessary. The strychnin with the laxative is never enough to do any harm unless the drug is being taken independently in sufficient doses. A better addition to the laxative mixture would be a small dose of capsicum or piperin. The laxatives act more or less as general systemic tonics, and there is no objection to their being continued for a long time if they agree with the patient.

The saline laxatives are entirely eligible if they fit the patient. I should say, however, that they do not, as a rule, agree as well as the vegetable ones. The most useful form is a mixture containing the phosphate and sulphate of sodium in about equal parts with a quarter of a part of bicarbonate of sodium, a heaped teaspoonful of the mixture being taken in a large draught of hot water once a day,

or oftener if necessary, and half an hour before a meal. Calomel does not agree with tuberculous patients as well as with most other sick people, and the habit of taking it in rather full doses to " clean off " a coated tongue or to remove feelings of " biliousness," as many patients do without advice, is vicious, for it fails to do these desirable things, and it does debilitate the patient instead.

For the average patient the best laxative is a large enema of warm water or warm normal salt solution; it agrees with more and disagrees with fewer patients than any drug or combination of them. If this fails and drainage is defective, then laxatives must be given regularly, and from among the best the idiosyncrasy of the patient must determine which is most adapted to his case.

Anodynes are occasionally required in tuberculosis, especially the pulmonary form, and chiefly for two very particular conditions — namely, pain and excessive cough. A pain that cannot be quieted by warmth to the part, counter-irritation, and rest (or, if in the side, by fixation of the chest-wall by adhesive straps or bandages, which, if motion of the lung can be spared, should always be tried) requires some anodyne if the pain is not easily bearable. The most eligible drug for this class of patients is probably codein and its salts, although for a slight pain of evidently temporary character some of the

coal-tar preparations often act pleasantly. Opium and morphin should be avoided if possible. The pain most likely to call for an anodyne is in the intercostal nerves or the pleura; headache is not very common; joint-pain is not infrequent, but is rarely so severe as to call for an anodyne, provided the joint is kept still and warm. Rather free counter-irritation with tincture of iodin, croton oil, chloroform liniment, ointment of biniodid of mercury, or small blisters will usually relieve the pain in the chest, back or limbs, and avoid the need of quieting drugs.

The cough may require anodyne drugs if it is too violent, if it is useless as failing to bring up phlegm, if it tires the patient greatly, if it keeps him awake to his evident injury, or if it is attended with much pain. It is best to abolish all cough that does not with fair ease bring up phlegm; but drugs should not be given until warmth of the chest and neck has been tried, nor until the patient has done his utmost to stop the unnecessary cough by his own will-power. These failing, medication should be resorted to, and those agents used that will disturb digestion and nutrition least. It is no harm if they produce slight constipation — that is easily relieved by enemas; but the integrity of gastric digeston is a sacred thing and must be conserved to the utmost. The best cough medicines are codein and heroin, neither of which is objection-

able to the average patient on the conditions named. A quarter grain of codein (or sulphate of codein) or a third as much heroin will often produce a quiet night for a patient who might otherwise, through his cough, lose half his required sleep, to his great injury. Two or three doses of these drugs in a night will be allowable if needed.

Occasionally a tickling in the throat — *i. e.* the larynx or trachea — produces a most vexatious cough that continues for an hour. Sometimes this may be quieted by a pungent thing in the mouth and pharynx, like a gargle of alum-water, a lozenge of capsicum, a swallow of whiskey, some highly flavored candy, or chewing dry and swallowing slowly a half grain tablet of acetanilid. A spray (to be described more fully later on) of carbolic acid in albolene, or nebulized fluid of this or some similar quieting substance, taken for a few minutes occasionally, will sometimes quiet this kind of a cough. Occasionally it is helped by applying a warm woolen bandage around the neck. Very often at night it is produced by lack of sufficient clothing about the neck, arms, and shoulders while in bed; then the remedy is obvious. The clothing about the upper part of the body in bed ought to be as thick and warm as that worn during the day — or even to exceed this; but such is not the practice of most people, either sick or well.

It has for generations been fashionable to give coughing patients expectorant drugs, whether they are expectorating freely or not, whether their coughs are tight or loose. Most of these drugs are of the nauseant or sedative kind, and calculated, when given freely, to produce nausea and a free flow of saliva, and of serum from the bronchi. Antimony, ipecacuanha, squill, and senega have been much used, apomorphin less so. When the cough is "dry,"—*i. e.* without expectoration and therefore useless — their addition to small doses of anodyne drugs is not specially objectionable, provided they do not interfere in the slightest degree with the taking of food or with digestion. As a matter of fact, they have in the past been used domestically, and often prescribed in the most routine manner, and used recklessly by vast numbers of patients. They have probably done in the aggregate much more harm than good as they have been employed. As a rule, they had better not be prescribed, for they often do interfere with the digestive organs and probably cause coating of the tongue, and to give them when there is no useless cough is bad practice. Nor is it probable that the nauseants assist to any valuable degree the effect of anodynes that may be prescribed to quiet a cough. The opiates given alone have substantially the same effect on the cough, and no objectionable feature of the action of any of them is counteracted by the nauseants to an extent that warrants their use.

Local medication of the respiratory passages has some, but not great, value. Its chief good is to assuage annoying sensations in the throat and trachea. Various sprays and nebulized or atomized fluids and vapors have been used in the hope of destroying the bacilli in the lungs, but they are all entirely powerless to do it without doing mortal harm to the patient. They may at times, and when used freely, repress to a slight degree the bacilli on the surfaces that the medicine touches, but this can never be any region of the lungs where mischief is going on. The bacilli that do harm always produce their havoc beneath a layer of mucus that no coughing can ever carry away completely, and usually beneath the surface of the mucous membrane, and no projected particles of medicament can ever reach them in these situations.

This form of medication, however, may do good to the mucous membrane near the tuberculous lesions and which is irritated by the disease. Often the conscious irritation in the breath-passages is entirely confined to the non-tuberculous congested mucous membrane in the neighborhood of the lesions and usually proximal to them. To these surfaces some soothing application may be a great boon; it gives the patient comfort, and possibly retards the spread of the disease to adjacent tissues.

Such medicines should be used whenever they are agreeable to the patient and as often as he likes. The best of them are composed of albolene or some similar oily substance for a base, and some fragrant and agreeable admixture that has a harmless, slightly anodyne, and possibly antiseptic effect. Of these the best are carbolic acid, creasote, menthol, oil of cloves, and oil of pine. A few drops or grains to the ounce (¼ to 1 per cent.) are enough, and the best apparatus with which to divide the medicament is one that makes a cloud of perfectly nebulized substance. For this a pressure tank of air is useful but not indispensible; pressure can be made with an ordinary bicycle-pump, forcing air into a nebulizing jar from which the medicine is carried through a tube to the patient's mouth. An ordinary atomizer of the best pattern with an effective hand bulb will do in the absence of a better machine; only, if the patient is weak, some other hand than his should work the bulb. Inhalations of such medicines, if they are to be used with efficiency, should be taken frequently; hence it is necessary that the patient should have the proper facilities himself, and not be obliged to go to the doctor's office for the treatment.

Inhalation of the vapor of soothing or stimulating drugs from cotton or a sponge in a tube with open ends or from an empty bottle is sometimes both

agreeable and beneficial. The iodid of ethyl, creasote, carbolic acid, and eucalyptol are proper. They are best used dissolved in alcohol or compound spirits of ether, and should not be stronger than 5 to 15 per cent. If there is much annoying cough, the ether preparation is the better excipient. Three or four whiffs from the apparatus may be taken every hour during the day, and if found desirable, the bottle or tube may be left under the patient's pillow, uncorked, all night. The apparatus should, of course, be tightly corked when not in use.[1]

The menthol tubes so much used by inhalation for their supposed effect on headache and common colds will frequently allay a tickling sensation in the throat if used rather freely. The inhalation of oil of peppermint with the hope of destroying the bacilli of tuberculosis in the lungs, as recommended by Carasso, has been used considerably, and with some evidence but no proof of its special value. It is not unlikely that the vapor of the oil, if carried into the lungs almost constantly from inhalers worn day and night for a long time, may destroy the bacilli on the very surfaces where it strikes, but it does not penetrate beneath the surface to produce

[1] A good formula is:

℞ Ethyl iodid.............................. fʒ½
Eucalpytol . ...fʒ½
Creasote . . ..fʒi
Compound spirits of ether ....q. s. ad ℥i —M.

Sig.—Drop in inhaling tube as required.

any effect, and, as already said, it is there that the chief mischief is always going on in pulmonary tuberculosis; there bacilli are multiplying in vast swarms, to spread in every direction where they find resistance low enough.

CHAPTER XVI

TREATMENT, MEDICINAL—(CONTINUED)

TUBERCULOSIS of the larynx has received varied and numerous local treatments, most of which have had little effect, while some of them have been positively harmful to a high degree. In considering these cases we should understand, to begin with, that tuberculosis of the vocal cords is a matter of little inconvenience except from the hoarseness and aphonia; it is not painful, and it does not interfere with deglutition or in any way immediately imperil life; moreover, it is sometimes recovered from. It sometimes interferes a little in the expulsive cough, by the difficulty in closing the glottis firmly enough to get a strong blast of air; but probably no patient suffers any evil effects from retention of pus in his tubes in consequence. On the contrary, it may spare the lungs from some injury that might result from straining cough.

It is the disease of the arytenoid regions and the space between them, as well as the epiglottis, that is so grave a condition in laryngeal tuberculosis. This causes painful swallowing; pain often when the throat is at rest; and, after ulceration has come, sometimes violent cough, even strangling, on at-

tempts to swallow. Only very few people recover from this form, for it leads to such resistance to taking food as to amount to starvation in a short time, and this, with the poison of the disease, rapidly pulls the patient down.

No local treatment of the larynx in any of these cases should be thought of unless it promises either to relieve discomfort or to increase the prospects of recovery. The severe treatments have so far signally failed to do either. They consist of applications to the ulcerous surfaces and the swollen tissues about them of strong stimulating or cauterizing drugs, the chief of which has been lactic acid in nearly or quite full strength; and the effect has almost invariably been to cause a great deal of pain of body and mind, without staying the course of the disease. These measures have in the main been one pathetic death-tragedy, often prolonged, and without a ray of solace to the patients.

The indications for treatment are to lessen discomfort and to keep the ulcerous surfaces as nearly aseptic as possible, so as to favor the healing by the natural forces. The former is fulfilled by sprays of local anesthetics; the latter is poorly fulfilled at best, but some benefit comes from the use of sprays of antiseptics. Fortunately these two indications are covered largely by the same drugs; but the list is small that can be used with safety, for nothing

must be employed that will harm the system by being absorbed from either the throat or the stomach. All medicaments used with the spray are swallowed to a certain extent, and even those that are applied carefully by the physician are often swallowed. The most ideal application for comfort is, of course, cocain (in a 2 to 4 per cent. solution), but when used its dose has to be increased rather rapidly, it fails to give much relief, and its injurious systemic effects become a great drawback. Eucain (A) is a more eligible agent with fewer disadvantages. It may be used in a 2 or 3 per cent. solution; but its solutions do not keep well and must be renewed frequently. Orthoform is better still, for it produces very little, if any, constitutional effect, and it has perhaps some antiseptic influence. But the orthoform must be insufflated as a powder,[1] and frequently the patient tires of the annoyance of its use and complains that it has not been blown upon the right place. In most of these cases it is better to rely on the slight benumbing effect of menthol,

[1] Orthoform 4 parts, sugar of milk or powdered acacia 1 part, make an eligible mixture; but the orthoform is often used pure, only it is liable to pack in the insufflating tube. The best form of tube is the ordinary slightly bent one in common use for taking medicine. A half inch of its end is bent at a right angle to its straight side, in an alcohol flame, and the other end attached to a tube of rubber one foot long. The bent end of the tube is dipped in the powder, and the blast of air is blown from the operator's lips or from a bulb. The bulb is better, as it does not carry breath-moisture into the tube to clog it.

carbolic acid, or oil of cloves, any one of which may, in weak solution, be sprayed into the throat often without harm. No amount of these drugs that would ever be swallowed when used as spray can do any particular harm. The carbolic acid may be used in ½ to 5 per cent. solution in water or albolene (2 to 20 grs. to 1 oz.); the menthol in a 5 to 10 per cent. solution in albolene; and the oil of cloves in a saturated watery solution (0.75%). To give comfort, they should be used shortly before eating; and they may also be used with safety after every meal. Morphin may be added to these medicaments, but I think it is rather better to give it internally or hypodermically if it is necessary to use it. It should be used with great caution.

There is one drug that offers some hope of healing laryngeal ulceration, and it may be used with a spray. That is the trichlorid of iodin, a strong germicide that seems to penetrate deeper into a tuberculous ulcer than any other non-toxic agent, and to favor healing. It may be sprayed in 1-10 to ¼ of one per cent. aqueous solution (½ gr. to 1 oz.), the strength being increased if tolerance permits. But it is an irritant if the solution is strong. There is no objection to using it frequently. The drug is rapidly decomposed on touching the ulcerous surfaces, setting free iodin and chlorin, which in their nascent state are very destructive to microbes.

The preparation so readily decomposes that it is important to have it always fresh and perfect.

Frequently a patient will complain of pain in the throat, with swallowing or otherwise, when no lesion can be discovered to account for it. Then usually the trouble is in the deeper tissues, the nerves or muscles of the throat, and in pathology is probably not unlike the slightly painful joints so common in this disease. Sometimes the pain is quite evanescent, lasting but two or three days. It is sometimes called rheumatic, although probably by a wrong use of the word. No treatment is required for it.

Some symptoms of tuberculosis are so troublesome as to demand special consideration. The most constant of these, if not the most portentous, is fever. It often occurs in some part of each day for many months together; sometimes it continues a large part of each twenty-four hours. It is the one symptom that, more than any other, may be depended on to reveal the progress toward recovery or the reverse. If much fever is present, it shows there must be some mixed infection, and conditions that, if they continue long enough, must wear out the patient and destroy life. But moderate fever lasting only a part of every day can be borne for a very long time with only slight peril; nor is it true, as was formerly supposed that moderate fever is *per se*

specially harmful. It is the thing that produces the fever that does the great harm by impeding the physiologic processes and bringing on cachexia and all the long train of conditions that cause death.

Very high fever may cause delirium and unconsciousness, as in sunstroke; but such symptoms are most unusual in tuberculosis. Occasionally the patient feels uncomfortable in the head or elsewhere during the highest temperature, and needs an antipyretic. Then antipyrin, phenacetin, acetanilid, or some similar drug may be used with caution. The temptation is great, especially to the young practitioner, to treat the fever actively. But, as a rule, the only treatment that is useful consists in sustaining the powers of life and keeping the patient still. Certainly no antipyretic drug treatment for the fever has so far shown any power to stop its recurrence or shorten its period or increase the prospects of ultimate recovery.

A few years ago a large number of doctors all over the country found themselves ready to confirm somebody's hypothesis that guaiacol freely rubbed into the skin would promptly "bring down the fever;" they even reported numbers of their own cases to prove that such a result followed. Now they have generally ceased to use the drug, and probably regret that they reported their cases, and wonder why they ever believed the hypothesis. There

was not, I am sure, any scientific reason why they should believe in it, for the guaiacol manifestly had no effect on the temperature. The fever fell in some cases a short time after the rubbing was done, and fell for some reason connected with the action of the fever-producing agent in the blood, and the rubbed-in drug got the credit of it.

The night-sweats of phthisis are often a serious inconvenience, and, according to popular belief, a danger as well. The patient is sure to think his sense of prostration of the day is due to the sweat of the night before, wholly ignorant that the high fever and profound pus-poisoning that caused the fever could have anything to do with it.

Great weakness does, indeed, attend conditions where profuse sweating occurs, but there is no proof that the sweating causes it. The phenomenon is in some way connected with a phase of infection where high fever falls suddenly, and the sweat comes when the temperature drops. The perspiration carries away a good deal of poisonous matter as well as salts, and this is without doubt something of an advantage to the patient infected by pus and tuberculosis. And the saline matter and water are easily replaced by the food and drink. It is not proven that a night-sweat is not a conservative process, to be encouraged rather than otherwise; and until the proof exists physicians should be careful to avoid strong and function-disturbing measures to stop it.

The sweat is disagreeable by the amount of it, and patients think their night-clothes must be changed the moment they awaken and find themselves moist, for fear of taking cold; but there is no danger of catching cold so long as the body is warm, nor is there need of changing the clothing during the night except for sensations of comfort. The patient's definition of a night-sweat is often faulty. He is liable to apply the term to a trifling perspiration, mostly above the waist-line, that slightly moistens the night-clothes. These minute perspirations are usually due to trivial nervous causes, and they are hardly an inconvenience except to the mind. It is the colliquative sweats, which wet the night-clothes and the bed-clothing almost to the dripping point, and even moisten the mattress, that alone ever require medical treatment for the relief of the discomfort they produce.

I am not satisfied that the sweats require treatment, since they neither cause the weakness complained of nor harm the patient otherwise. And it is an open question whether we ought, on the solicitation of the patient, simply for his comfort, to try to prevent the sweats, when to do so we should be obliged to give drugs that disturb the digestion or some other function that is important in maintaining the powers of life. My own view is that treatment

is very rarely justified. There is no treatment that is even fairly efficient, any way; the best single remedy is perhaps atropin, and that drug is of questionable value unless given to the extent of producing its full physiologic effect — which latter is disturbing both to functions and to comfort. The aromatic sulphuric acid treatment has, I think, no effect on the sweating, although the drug is something of a tonic, and is therefore unobjectionable. The local applications are all useless. When, as will occur in the absence of treatment, there happens to be a night without a sweat, the patient and his friends are very likely, if any treatment has been resorted to, to attribute the improvement to it; and this is almost the sole basis of the reputation of drugs and applications for night-sweats.

The one measure that the physician should never omit is an insistent statement to the patient that his sweats do not harm him or cause weakness, but are due to the cause of the weakness, which is another thing altogether. If this declaration is repeated often enough, the patient will usually believe it, and stop worrying unduly about his sweats.

Many patients with tuberculosis fail to obtain the proper amount of sleep. They are kept awake by a great variety of causes, some of which were discussed in the chapter on the general principles of treatment. The chief causes of insomnia are cough,

fever, sweating, pain, indigestion (sour stomach), constipation, diarrhea, and mental worry. Cough is the most potent cause, and if this can be reduced and any of the other existing causes corrected, sleep usually ensues after the fatigue of the day. Obviously, all the causes named cannot always be removed, but efforts should be made to do this by hygienic and symptomatic treatment carried out in a careful and painstaking way. Usually it is possible, except in a few very nervous patients, to secure enough sleep without soporific drugs, but occasionally nothing seems capable of doing this but a sleeping potion. The best of all are sulphonal and trional, in the usual dose of 5 to 15 grains. Trional is rather preferable of the two, and 10 grains is enough usually. But these drugs should never be used continuously for many weeks at a time; their proper field is as an occasional relief. Bromides sometimes act pleasantly, 10 to 15 grains of the sodium salt being used two hours before bed-time. Occasionally a stimulant, as a moderate dose of whiskey well diluted, or a glass of beer, will compose a patient for the night. If the stomach is sour, a dose of aromatic spirits of ammonia, well diluted, sometimes does good; or a liberal dose of bicarbonate of sodium may be taken with benefit. For nervousness that prevents sleep, such nervines as valerian, sweet spirits of nitre, and asafetida ought to

be used more than they are at present, and in more frequent doses than is usual.

Pulmonary hemorrhage is a symptom that always disturbs and often terrifies the patient and his friends, and there is usually an urgent demand for something to stop it. Small hemorrhages are useful rather than otherwise, and require no treatment beyond carefulness on the part of the patient to avoid creating an increased blood-pressure, and thereby perhaps opening larger vessels. The patient should keep still, recline with the head high, avoid excitement, eat sparingly, avoid constipation, keep the head cool and the body and extremities warm, and be as serene as possible in his mind. If he takes any drug, the preferable one should be some opiate — that is, opium or some of its preparations. Of these, morphin is the best, and had better be taken with the proper admixture of atropin. If the hemorrhage is at all free, the hypodermic method should alone be relied upon; it is worse than useless to depend on absorption from the stomach or the rectum in such cases, for a quick effect is imperative. Moreover, in a severe hemorrhage the patient often vomits a great quantity of mucus and blood before the attack is over, so that the chances of any medicine being absorbed from the stomach are very small. A quarter grain of morphin with 1-150 grain of atropin is a fair dose for an adult, and

this may be repeated with caution if occasion requires. But it ought not to be given at all for a trifling hemorrhage, a slight spitting of blood in occasional mouthfuls, unless the patient is demoralized and frightened. The opiate tranquilizes the mind and drives away fright, and this is one of the cardinal advantages of the drug. To do a large service physiologically to the part involved, the drug ought to lessen the blood-pressure in the deep regions of the body. It does not do this to any large degree, yet it is much the most useful medication that we know of.

The common habit of giving ergot in cases of hemorrhage from the lungs is most reprehensible, for it increases the blood-pressure and so makes it more likely that a vessel-wall made fragile by tuberculous deposit will rupture. Ergot always increases the bleeding in these cases, never decreases it, yet by a sort of fatality a large proportion of even intelligent physicians continue to use it. Its use for bleeding from the lungs has been a sort of fad among certain doctors, and a foolish if not a wicked one, that started in the groundless notion that good would somehow be done by contracting the blood-vessels. But the vessels whence the blood comes cannot contract in response to this or any other drug, for their muscular fibers are powerless, and by contraction of all the rest of the vascular system an

increase of blood-pressure everywhere is produced, which puts the diseased, fragile vessels upon greater strain than before. There is in the whole range of professional experience hardly a more striking example than this of the frequent prescribing of a potent drug with an effect the exact opposite of the one intended. If the fad were less harmful, it would be amusing.

From current reports, some promise of relief from hemorrhage seems to be offered by suprarenal extract (or adrenalin) given internally. But if the purpose sought is to contract all the blood-vessels, then we shall probably be disappointed, for this is what ergot does — to the increase, not the decrease, of the hemorrhage. But possibly this wonderful substance has some other power over hemorrhage, and is the great coming remedy.

One of the best measures, in addition to quiescence and opiates, is to tie handkerchiefs firmly around the limbs next to the body. This segregates the blood to some degree in the limbs and tends to lessen the blood-pressure in the center of the body.

Another measure of easy application and great value is (if the lesion is unilateral) adhesive straps to the diseased side, to immobilize the lung, after the manner already described. The straps should be numerous, and should be drawn as tightly as possible. Of even greater value is inflation of the

pleural cavity with sterile air or nitrogen gas. This puts the diseased lung to complete rest, and does it promptly, and the hemorrhage usually stops at once. Unfortunately, it is only in the rarely exceptional case that this measure will ever be resorted to promptly. But it can be used promptly and efficiently in cases without adhesions; for the simple device already referred to of an aspirator needle and tube can be employed, or a large hypodermic needle with a bit of cotton wrapped about its head. Every physician carries this instrument, and there is no more harm or pain in using it than in giving a hypodermic injection. A good way is to insert the needle at a point least likely to encounter adhesions — as far away from the lesion as possible — and leave it there for a few minutes, gently changing its depths in the body from time to time, till, if possible, the inspiratory movements of the patient shall begin to suck air into the pleural cavity. Then the needle should be pushed far enough to be sure that it has passed clear beyond the chest-wall and free into the pleural cavity.

If the temperature is high at the time of a bleeding, it should be promptly brought down with antipyretics, and if the pulse is hard and full, aconite and veratrum may be justifiable for their effect on the heart's action — not to lower the temperature, for they do not produce this effect.

In case of a very large hemorrhage the pulse should be watched carefully, and if it becomes very faint, hypodermoclysis of normal salt solution ought to be resorted to promptly. The best place to introduce the fluid is in the subclavicular region; and for apparatus an ordinary fountain syringe and an aspirator needle from the physician's pocket case constitute the necessities. The syringe can be cleansed, if necessary, with scalding water, and the needle may be held for a moment in a gas-flame or over a lamp-flame; the apparatus is then ready. The solution may be quickly strained through a clean cloth or a bit of sterile cotton as it passes into the bag. The solution can be made in an instant with a heaped teaspoonful of table-salt to a quart of any drinking water, preferably that which has been boiled, although that is not indispensable. This mixture is not exactly the equivalent of the water of the blood, but it is near enough for all physiologic purposes.

The custom is to heat the solution to 100° F. or over before putting it in the bag, in the expectation that it will pass through the needle at a temperature not below that of the body. But this end is very rarely attained; the solution passes so slowly that when it enters the tissues its temperature is often only 85° or 90° F. A much better way is to pour the unheated solution into the bag, and then to im-

merse a coil of the tube (near the needle) in a dish of hot water containing at least a quart. This water should be renewed as often as it gets cool.

The hypodermoclysis, while necessary at times to save life, may undoubtedly be carried so far as to increase the blood-pressure to the danger point. This we should be careful to avoid. Remember that it is desirable that the pulse *should* become weak and the blood-pressure low; for in these conditions is the greatest hope of a firm and obliterating blood-clot at the bleeding point.

CHAPTER XVII.

SPECIAL TREATMENTS

UNDER the name "serums" are included a number of substances that have been used for tuberculosis, and which have their origin either in the tubercle bacilli directly or in the bodies of animals in some way treated with the products of the bacilli.

One of these is the so-called *horse serum,* which is the blood-serum of the horse after the animal has been treated by repeated hypodermic injections of tuberculin. The theory is that by this treatment there is developed in the animal's blood an antitoxin to tuberculosis, after the manner of the diphtheria antitoxin which has been so successfully used against that disease. There is much to justify such a theory. The serum is used hypodermically, and, unlike that for diphtheria, which is rarely used beyond the second or third dose, it is given in a dose so small as not to produce fever, and repeated daily or every second day for a long time. It is usually injected into the back, deeply beneath the skin, in doses of 10 to 15 drops. It produces some local swelling and inflammation, and in susceptible patients occasionally a small abscess. Some people have a good tolerance for it, and take a large number

of injections with little complaint or discomfort.

Occasionally a disagreeable, if not dangerous, nervous shock is produced by the injections of horse serum. It occurs one or two minutes after an injection has been taken. Its symptoms are pain in the abdomen, general discomfort, flushed face, and a feeling of great fear and apprehension, all of which pass off in a few minutes. If the dose of the serum is too large, it is sure to cause fever for a few hours.

The experience with this serum has not been very satisfactory. Some practitioners have reported good results, others remarkable ones, and still others bad or indifferent ones. The testimony has been so various and contradictory that it is difficult to determine just what the effect upon the sick has been. Certainly no observer has recorded results based on the use of the serum in a large series of cases, under control with another series of similar cases managed in an identical way with the single exception of the omission of the serum. Until such records are made we cannot be said to have any scientific data on which to base definite conclusions as to the effect of this agent.

On the lower animals, especially guinea-pigs, really scientific observations have been made, showing that when treated with the horse serum an animal's life after inoculation with human tuberculous sputum is considerably prolonged over that of the

control animals. This seems to be the uniform result of laboratory tests. Yet the results of the use of the serum on human beings at the hands of careful observers has not been more than slightly beneficial. And the good results reported have in every instance been based on the observation of a few patients, without controls for comparison, and therefore with no means of knowing positively that they would not have done as well without the serum.

I have repeatedly employed this serum, sometimes with apparent good effect, and see no objection to its cautious use in any case where it produces no special discomfort or phlegmons or other terror to the patient, and provided always that no other element of the best treatment, hygienic, sanitary, or medical, is omitted in the slightest degree. This last condition is one that is usually forgotten and for this reason the total result of the serum treatment of all kinds and forms has been probably a little less than nothing of value. The belief that the serum will somehow cure the disease absolutely, and that nothing else need be thought of, is a maggot that gets into the heads of many of the patients and some of the physicians, to the great injury of the prospects of recovery.

Tuberculin and several modifications of it have been used remedially with more or less apparent and alleged success. In doses of 1 milligram given

hypodermically, it usually causes fever in a tuberculous patient who is not in extreme cachexia and whose disease foci are not yet completely encysted. When tuberculin is used therapeutically, it is given in doses so small as not to produce fever, and repeated every few days. After a few injections a tolerance of it is developed to some degree, so that the dosage can be increased somewhat. The theory of its use is that it adds to the tuberculin in the blood and develops in the patient's body a resisting power to the disease greater than existed before. But the theory is unsatisfactory, as the effects of the tuberculin are neither uniform nor convincing.

The lymph has been used persistently by a few practitioners who believe they have observed good results. By the majority it has been condemned as not only useless but harmful, and they have refused to even try it. They have argued that the patient is daily casting quite enough tuberculin into his blood and tissues from the cultures of his own disease, and that no good can come of increasing the amount. But, on the other hand, much of the auto-developed tuberculin is absorbed in conjunction with pus-products which probably retard the antitoxic power of the tuberculin. Moreover, to increase the tuberculin in the blood beyond the quantity made by the disease may produce and increase some antitoxin for the tuberculosis.

Unfortunately, the use of tuberculin, except for diagnostic purposes, has been open to the same sort of objection as that to the horse serum. It has been used on a few cases only, and the results have probably not warranted either the extravagant claims for or those against it. The most thorough test yet made in America is probably that of Dr. Trudeau. His trial of it extended over a number of years, and was scientific and fair in every way. His records show that those treated with the lymph, by comparison with other similar cases treated without it, did better by a small percentage. But he says that the benefit shown was "not sufficiently marked to be in any way conclusive." All the experience with this agent seems to show that under proper precautions it is devoid of danger, especially in cases with a fair degree of vigor — and it should never be used in any other cases. That being true, there is no reason why it should not be used more extensively. There are several conditions that should be insisted on if one is to use it therapeutically. The dose must be so small as to produce only slight local reaction in the form of moderate congestion of the diseased area, never constitutional reaction to the extent of distinct fever. This practically rules out all advanced cases with mixed infection, and restricts its use to the early and mostly non-febrile cases. It is necessary to begin with a small fraction (1-100

to 1-150) of a milligram for a dose, and repeat it rather often, every two or three days, increasing the dose as tolerance is established, gradually lengthening the intervals and giving always the largest dose possible short of producing febrile reaction. The injections are least likely to produce phlegmons when made deeply beneath the skin.

After marked tolerance to tuberculin has been established — which never occurs until it has been used for several months — it is a good plan to stop its use for some weeks, and resume it later. But it will then be discovered that some of the tolerance has been lost, and it will be necessary to start again with smaller doses. Then, after having the treatment worked up to the maximum dose, it will be well to omit it again and resume it later, and so on as long as there seems to be any hope of its doing good.

Koch's *tuberculin T. R.* may be used in the same way as the ordinary tuberculin, only in slightly smaller doses. I am not aware that it has been proven to have any therapeutic superiority over pure tuberculin, while it is distinctly more likely to produce irritation at the point of injection. Injections of tuberculin, when made deeply, very rarely cause any inflammatory action at the point of injection.

Several modifications of tuberculin have been used

besides the T. R. product. One is known as *antiphthisin,* and is said to consist substantially of tuberculin that has been freed, by some chemical process, of a part or all of its fever-producing ingredients. It is used by the hypodermic method very much as other serums are, and may be useful in some such way as the tuberculin is, but we lack as yet any definite scientific proof of its value.

The *tuberculocidin* of Klebs is the same as antiphthisin, with the addition of some kind of an extract of the bacilli. This is more likely to be useful than the antiphthisin, but its value is based on the same sort of observation as that of the other agents. Klebs believes that this substance is absorbed as well from the rectum as from beneath the skin, so he uses it by this and the hypodermic method indifferently, in doses of 10 to 15 drops hypodermically, or a quarter as much more injected into the rectum. In using it in this latter way it should be diluted with 2 or 3 drams of water, and taken after the bowels have been evacuated, so as to insure the most complete absorption.

Von Ruck has used extensively his *watery extract of tubercle bacilli.* He believes it to be much more efficacious than any form of tuberculin. A few physicians have used it and testify to its value. I hope it is as valuable as they think, and believe it deserves an extensive trial in comparison with pure tuber-

culin. But so far as I am aware, no such scientific comparison has been made with series of cases, as none has been made with it and under control of non-serum cases. Until such tests are made we cannot speak with any degree of positiveness of the value of these or any similar remedies.

Any physician who will treat with a particular serum every alternate case that comes to him, recording the others as controls, and managing all the cases otherwise in the same way in every particular, will, when his cases reach a hundred or two, have something of value to say to the waiting profession and to an army of tuberculous patients. Our misfortune, if not our fault, has been that we have mostly let our enthusiasm run away with our science, and been content to believe or guess that a serum was good, and so have used it, chiefly without control or system, and on cases likely to recover by rest and good hygiene. By thus having nothing proven we have thrown doubt and discredit on the whole subject, and have not added anything to the knowledge of the world.

CHAPTER XVIII

SANATORIA FOR TUBERCULOSIS

Sanatoria for tuberculosis have many advantages for the treatment of cases over any sort of home management.

Tuberculosis is a type of the long continuing diseases. Depending on the tissue attacked and on the resisting power of the patient, the disease lasts from a few days to many years, and in hopeful cases the great desideratum is for means to combat it in a persistent campaign, for several years if need be, without a break in the perfect continuity of its strenuous tension. There must be no relaxation of watchfulness to prevent surprises; no lessening of the resisting forces by unsanitary conditions of life that would lower the vitality of the factors of defence. There must be no sleeping on watch in this camp, nor dissipating of powers by unwholesome pleasures, nor engaging in industries not necessary to the perfection of the bodily forces as a power of defence. And there must be no loopholes in the lines of resistance, for the enemy is one that never sleeps nor rests wherever it can find physical conditions adapted to its work; it requires no intelli-

gence, but works with the precision and fate of an automaton.

For such a campaign against this disease the prospects of ultimate success are best when it is conducted in a climate best adapted for it, under residential conditions most fit, and under the care and observation of experts in this sort of a campaign, who are not likely to relax their watchfulness or lose their wisdom about it from one year's end to another.

These conditions are in the average case best attained in sanatoria for tuberculosis. This truth is so plain as to be really self-evident. It is a truth that needs no argument that these best conditions can be found neither in the average household nor in the routine of the life of the average patient. A few patients of unusual self-control and wisdom, whose families and attending nurses and friends have sense and decision, and who have the means of surrounding themselves with all the comforts, can do as well or even better than at the best sanatoria; but these are rare exceptions.

The allurements of business and pleasure and of social dissipations; the temptations of appetite and the fashions of eating, of dress, and of social usages; the love of travel and the desire to roam from place to place — putatively for health, but mostly for mental diversion,— these are dangers

that handicap most patients with chronic tuberculosis who live at home or outside of an institution. They follow their inclinations chiefly, and try to carry out the advice of their doctors somewhat. Too often the sole advice that is followed is confined to the taking of some drugs, and perhaps residence in a particular place. If the doctor gives minute directions in all particulars necessary to accomplish the best effects, the patient usually finds that they are so radical, and so completely change all the habits and regimen of his life, as well as perhaps his occupations, that he is apt to think them unnecessary and fussy, and to be ready to neglect most of them. In a sanatorium he finds it easy to follow all of them, for there it is the fashion to do this; there is no temptation to the contrary, and the new life and novel regimen furnish both occupation and amusement.

The sanatorium for tuberculosis is, in America, a relatively new idea; until recently it has been unfashionable, and people have even dreaded the thought of going to such an institution or having their friends go there. They have hated hospitals of all kinds, and in a blind and foolish way. Fortunately, during the past few years the value of sanatoria and of expert care for such cases has come to be better understood and appreciated. Such institutions, until recent years confined to one or two

in number (that of Dr. Trudeau at Saranac Lake, New York, easily being the pioneer, to the great credit of its creators and management), are now springing up in many parts of the country, and meeting with the success that their enthusiastic advocates have predicted.

Now that the evidence is growing that the great danger of acquiring tuberculosis is from human rather than animal patients, and that if the disease is ever destroyed as a pest of mankind, or even much circumscribed, it must be chiefly by a systematic and persistent destruction of bacilli from human expectoration, the need of such sustained care of sputum, clothing, and utensils of consumptives as sanatoria almost alone provide is being more and more appreciated. But the ignorance on this subject among the people is still very dense, and much enlightenment is needed even among the profession.

The great goal to work for is an atmosphere charged as little as possible with bacilli of tuberculosis. In no city of any civilized country is the street-air wholly free from them now, and with current methods in the care of tuberculous patients we cannot look for much improvement. Artificial destruction must reinforce the power of sunshine before that desirable end is accomplished, and sanatoria certainly succeed in doing this better than it is done anywhere else. The claim is not unfair that

the atmosphere within the walls and grounds of the best of the sanatoria is more nearly germ-free than that of the streets of any city. An uninfected person is therefore safer within them than at his home, especially if that is in an urban community.

But the regulations and methods of a sanatorium that is entitled to be classed as *the best* are something startling in their thoroughness. They include, besides the saving for destruction of every particle of tangible sputum, such precautions against the intangible and usually overlooked but always freely scattered minute particles of sputum as the following: Uncarpeted floors, unupholstered furniture, and both (as well as walls and ceilings) regularly cleansed at short intervals; regular and frequent sterilization by sunshine or heat of all clothing, beds, rugs, and every utensil used on or about the patients. They include constant watchfulness of the personal habits of the patients, and such searching precautions that no bacilli discharged from any part of the body of a patient can long escape destruction. And all these measures are carried out year after year without a break.

In what home of a tuberculous patient are any such thorough precautions taken? And yet it cannot be doubted that every one of them is necessary for every case if the community is ever to be protected. The greatest danger is, of course, from the

poor and careless patients. All people when greatly prostrated are liable to be careless in their personal habits; they are almost certain to be. The well-to-do and those who have attentive friends can, in spite of themselves, be kept in a fairly sanitary state; but the neglected ones are a constant menace to every uninfected person for miles around them. That menace is now just coming to be partially understood by the public, and it is beginning to dawn on us that for the common protection sanatoria at public expense are needed for such cases. And if the science of tuberculosis is not wholly reversed by future discoveries, there will gradually develop such a popular understanding of the danger referred to as will lead to the creation of such institutions all over the country. The cost to the public to build and support them would, of course, be enormous, but the loss to the community entailed by the neglect of the cases is now vastly more; it would be economy to take care of them as a public burden.

Great as is the advantage to the general public in having patients live in sanatoria, the benefit to the patients themselves is vastly more. They live perforce hygienically, and every day, and so have the best chance of recovery. They take the best care of themselves, for that is their occupation; and they take their peculiar diet and carry out the various hygienic rules as a matter of course. They eat

properly and regularly, and so far from violating the details of their regimen, they become advocates of it, and watch themselves and each other in a loyalty to it that is both novel and hopeful. There are no social allurements to harm; the social functions of the institution are planned for the sick. Female patients have little temptation to dress unwholesomely, and they easily consent to wear short skirts and loose clothes everywhere. This last is an almost indispensable condition to recovery; the conventional waist-clothing is an abomination to the consumptive woman. The nursing is done by experts who are little moved to do foolish things for the patients, either at their suggestion or out of blind love and sympathy for them.

The danger of overdoing is minified by the constant and wise watchfulness that is the habit of the institution and by the routine lives that the patients lead — which means the highest degree of wholesome living; and this is rarely attainable in one's home unless at the hands of a trained nurse not of the patient's family. One can live well and be well cared for at a sanatorium for what such a nurse often costs, or even less. The constant supply of fresh air, so hard to provide for a patient at his home, is always secured at such an institution. This is the most important remedy, the value of which cannot be overrated.

One of the greatest advantages of all is the mental tranquillity that comes to many patients through the fact of being in a small community where the chief fashions are to be quiescent and to do and endure certain things that are understood to be proper for the sick. Much depends on the emotional basis on which we do things. At home the basis is that of the well people, and we seek to do the things of the well, as in exercise, business, amusements, and diversions, and eat always on the basis of an appetite which we feel bound to cultivate and follow.

In a sanatorium the basis is that of the sick; we are glad to do the things of the sick in all these particulars, and we eat as a matter of routine, without feeling compelled to pay homage to appetite. This letting go of the emotional tension that makes a sick man try to be a well one and pretend that he is, often tips the balance in favor of recovery and saves the patient from a death that otherwise would be inevitable. If every person with pulmonary tuberculosis could from the very first give up and not pretend to himself or to others that he is well, but settle down with patience and attention to the business of getting well, the proportion of recoveries would be greatly increased.

The sanatorium life is conducive in a high degree to this good philosophy. It is attainable at home, but less easily; there the temptation to do all sorts

of things often begets an attempt to hide even the existence of tuberculosis as though it were a disgrace like drunkenness or opium-taking, to be spoken of only in an undertone, and even forgotten by the patient. This nearly always leads to the doing or omission of things that are inimical to the prospects of recovery. Those cases of tuberculosis where the patient is perfectly informed and is himself frank about it are most of all likely to recover, for they pursue, on an average, a more wholesome course of life and treatment, and they are exposed to decidedly fewer risks of all kinds.

The proper placing, the location, of a sanatorium is of great importance, although less vital than the management of the patients within it. It is essential that it shall be in the country, and far away from manufactories and all other industries and things that can contaminate the air or render it in the slightest degree unpleasant to the senses. There ought to be a free circulation of air, therefore an elevated spot may be desirable. Still, the situation would be unfortunate if strong winds prevailed so as to make outdoor life for the patients difficult. High hills to the east should be avoided, as they make a late sunrise; an early sunset is less objectionable, but is to be avoided if possible. Trees and verandas are desirable for shade from the intense sun, but never to make it hard to hunt the

sunshine. Scenery, trees, hills, rocks, and running water are good aids and make for contentment, but are hardly to be called essential. Nearness to a town has its good and its bad influences. Nearness means conveniences, and possibility of amusements, but it often tempts patients away from the contentment with the sanatorium life that is so necessary to the best progress in recovery.

Most patients can never go to a sanatorium, but must stay at home. Here they recover if they can, or die if they must. Many of them could carry out the true sanatorium management at home far better than they do; most of them never even attempt it — they find it too radical and inconvenient. For these enforced stay-at-homes the modern physician has a large duty and may do incalculable good, but he can do it only by insistence and watchfulness that are sustained through the years, regardless of the heedlessness, impatience, and even censure on the part of the patients and the public, and sustained by a determination to do a duty to both that neither of them can know with any such force as he knows it.

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